

JANUARY, 1962

BROADCAST ENGINEERING

®



THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY

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MAINTENANCE

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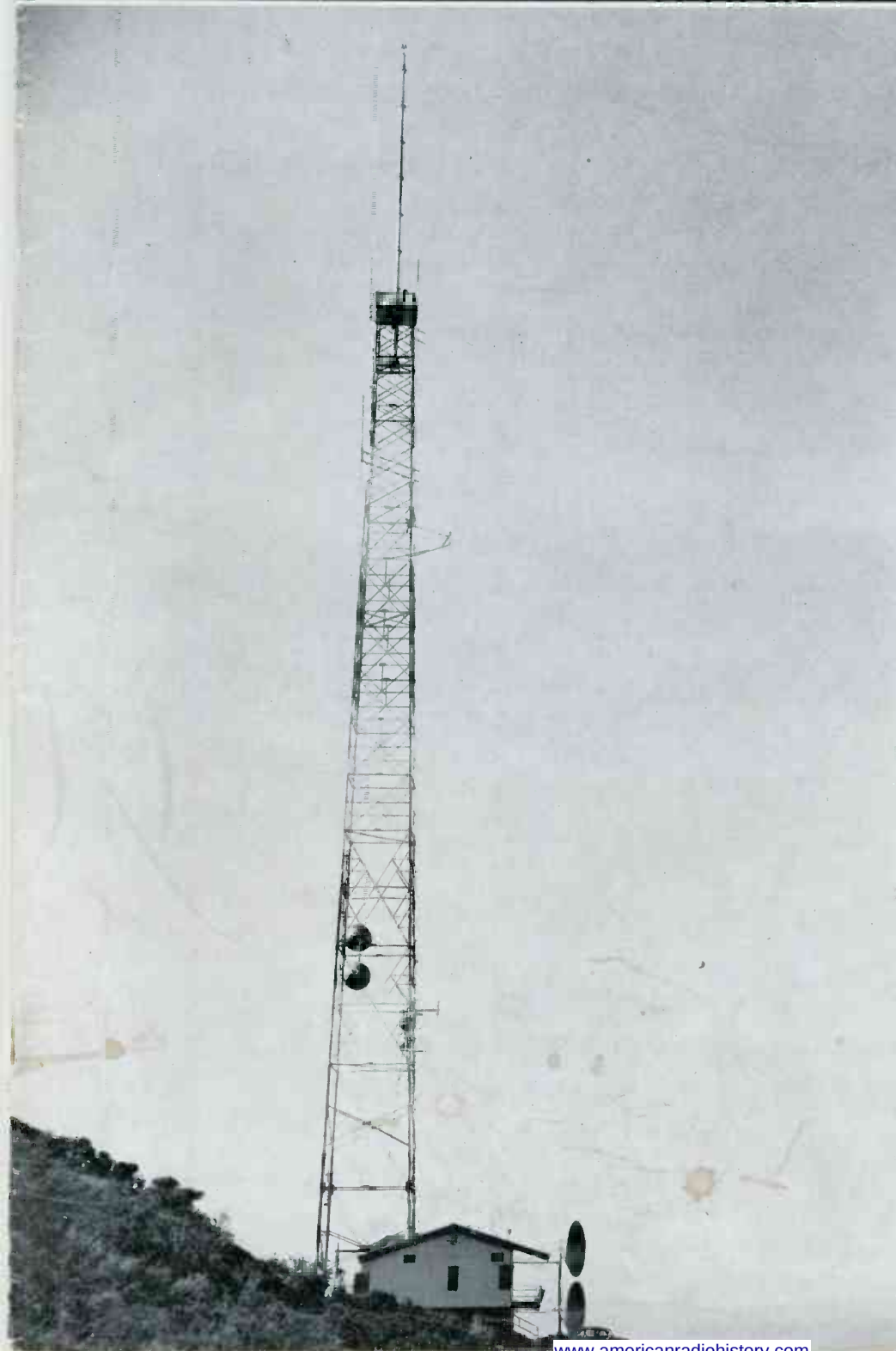
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Through a new tool in recording—Langevin's Exclusive

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- *Smooth continuous movement of the soloist at any speed through 180 degrees during recording.
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The preamplifier output of the microphone selected for panoramic use is fed to the input of the Pan Pot. The outputs of the Pan Pot feed to the combining networks of the 2 or 3 recording channels.

BACKGROUND

In 1934 it was well established that a level change of only 3 db was sufficient to displace the apparent source of an instrument or vocalist completely across the recorded stereo field. Langevin engineers developed the first panoramic controls for this application.

While it is also known that the arrival time of the sound influences the position of the apparent source, it has been proven that intensity offsets the effects of arrival time satisfactorily. In motion picture work at least three prominent screen processes clearly demonstrate the complete success of Pan Pots in achieving dynamic control over position.

THEORY OF OPERATION

The configurations of these mixer control assemblies are different from those usually found in transmission work. In the 2 channel controls, 2 oppositely wound networks are ganged so that the 3 db down point of each control occurs at zero degrees. In 3 channel arrays 3 controls are ganged so that the 3 db down points occur at 45 degrees each side of center, and so that at 90 degrees the extreme opposite control is at infinite attenuation. Note in the diagrams that attenuation of the extreme positions is unusually rapid, and that it is very slow in the regions of overlap from one control to another. This rate of attenuation is precise, and conforms to exact calculations governing angular displacement in the sound field with change in level.

ORDERING INFORMATION

2 CHANNEL UNITS

MODEL RPP-2 ROTARY PAN POT, for mixing 1 channel into 2. 600 ohms impedance in and out. Ladder type, insertion loss 12 db. 270° rotation with —3 db point at 0°, 90° at extreme right and left. 16 steps used per section. Size is $1\frac{1}{2}$ " diameter by $2\frac{7}{8}$ " long. Complete with K-111 type mixer knob and color coded dial plate. Weight, net $6\frac{1}{2}$ oz., 1 lb. shpg. Price, Net Each \$28.50

MODEL RPP-2T ROTARY PAN POT, Bridge "T", all other details same as Model RPP-2 above but $2\frac{1}{2}$ " diameter and 6 db insertion loss. Weight, net 13 oz., $1\frac{1}{2}$ lbs. shpg. Price, Net Each \$44.50

MODEL SLPP-2 STRAIGHT LINE PAN POT, 1 channel into 2, same as Model RPP-2 above but straight line form, for horizontal panel placement. Supplied with red knob and engraved, color coded escutcheon. Size is $1\frac{1}{2}$ " wide by 7" long by $2\frac{1}{4}$ " deep behind mounting plane. Extends $3\frac{1}{4}$ " to top of knob. Weight, net $6\frac{1}{2}$ oz., 1 lb. shpg. Price, Net Each \$64.00

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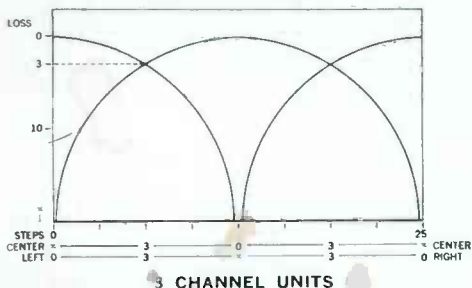
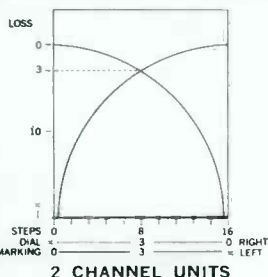
3 CHANNEL UNITS

MODEL RPP-3 ROTARY PAN POT, for mixing 1 channel into 3. Same as Model RPP-2 but with 3 elements and insertion loss of 12 db; left range tapers from zero attenuation to infinity in center at 0°. Right side of control is opposite on same contact row diameter. Center ganged control is zero attenuation at 0° with infinite attenuation at extreme right and extreme left rotation. Comes with Model K-111 type knob as well as dial plate. Size is 3" diameter and $2\frac{7}{8}$ " deep. Weight, net 13 oz., $1\frac{1}{2}$ lbs. shpg. Price, Net Each \$46.50

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MODEL SLPP-3 STRAIGHT LINE PAN POT, 1 channel into 3, same as Model SLPP-2 but with pots ganged and 12 db insertion loss. Weight, net 13 oz., $1\frac{1}{2}$ lbs. shpg. Price, Net Each \$102.50

MODEL SLPP-3T STRAIGHT LINE PAN POT, Bridge "T", all other details same as Model SLPP-3 above except 2" wide and 9.5 db insertion loss. Weight, net 13 oz., $1\frac{1}{2}$ lbs. shpg. Price, Net Each \$151.25



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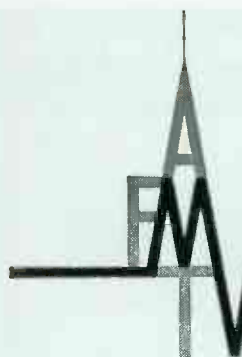
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BROADCAST ENGINEERING

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High on a peak of Mount Diablo in California this television tower is both the end and the beginning of an 82-mile educational TV, two-hop microwave link. Utilizing the 2,000 Mc. band, the system has better than 46 db video signal/noise ratio.

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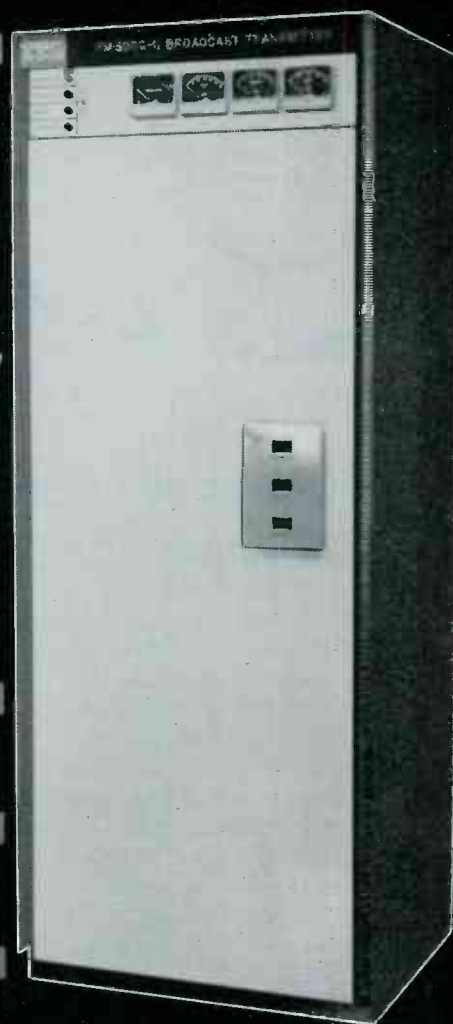
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The Editor's Cue Line



The Problem of FM Allocations

Well, the comments are in on the FCC's proposed new FM allocation plan using mileage separation instead of an engineering yardstick. As was to be expected the "Haves" in the form of the National Assn. of Broadcasters, and many of the larger broadcasting associations plumped for the Commission's plan to allocate FM frequencies strictly by separation between arbitrarily chosen cities and areas. This is the same system that produced the excessively wasteful TV allocations plan and resulted in the lying fallow of so many TV channels, and the assignment of only one or two channels in many towns where common need (and sense) dictated the allocation of more channels.

Organizations concerned more closely with the general good and needs of the listening public protested strongly against what is effectively a squeeze out of any new FM authorizations in the east and a definite lessening in the number of channels available elsewhere. The Assn. of Federal Communications Consulting Engineers (AFCCCE) placed a very carefully thought out paper before the Commission in which was pointed out that "allocations by distance, instead of allocations by engineering" would result in the grant of only eight out of 49 pending FM applications.

As engineers concerned with the healthy growth of FM and probably intimately connected with broadcasters who plan, or hope to plan, the addition of FM, our readers

should carefully study the implications of the FCC's proposals and not be afraid to let the Commission know their thoughts. This kind of proposal can have very deleterious effects on the jobs of many station engineers whose companies need to expand into FM to provide a night or improved service. Under the proposed rules they will be prevented from doing so if this ridiculous "allocations by mileage" plan goes into effect and many jobs will either not materialize or will be lost.

We feel that the attitude of the NAB is particularly shortsighted. Although it is natural for an organization to protect the interests of its own members, surely one that protests so much that it operates in the public interest should give greater thought to the interests of 180,000,000 Americans in general, and consider in its public pronouncements the technical advances that make it possible to use developments such as directional antennas in providing better allocations.

AM Freeze Coming?

The current freezing of 53 AM channels in order to implement and protect a doubtful decision within the next three years on the clear channels may presage a complete freeze on all AM applications. It is no secret that many members of the FCC favor such a move. To add fuel to their efforts the "Haves" again want to hold what they have, and stop any efforts by the "Have-Nots" to acquire new stations. Under the guise of "preventing deterioration of public service by radio stations" by limiting the number of such stations, many operators are on the verge of asking government aid in stopping the grant of more applications in their particular markets. They plead the peril of "economic instability" and inability of the market to support new stations. Before running crying to "Uncle" for help these faint hearts should pause and think of the far greater perils in *voluntarily* asking for far reaching controls. Every time federal government is invited to clamp down more

controls on industry, everyone suffers a little, and more freedom is frittered away. If broadcasters want freedom from competition through federal controls then why should not the corner grocery, or the candy store demand the same thing? Then the freedom of free enterprise that has made America the Great will be lost forever! Once imposed, government controls never vanish, they always spread like a fungoid growth.

The broadcasters' trade association, NAB, which should speak for *every* broadcaster, but which has far from 100% membership, again appears to favor the FCC freeze project. Some non-members hint darkly of domination by the networks and attention only to the needs and desires of the big contributors (dues are based on rate card charges). Surely a better plan is for the NAB to maintain a strong engineering group, and propose forceful and effective alternatives to the stifling effect of legislation based on fear of competition?



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TELEVISION SYSTEM MAINTENANCE

IV. Frequency Response and Amplitude Linearity (Part 2)

EDITOR'S NOTE:

Test signal generator outputs are shown by photos appearing in Part 1 of this article in the July issue. We regret that the photo of the Sine² pulse on page 17 was inadvertently printed upside down.

The Window Signal

The window is the most effective test signal available for determining absolute values of picture streaking. It is also useful in a more limited sense to evaluate low-to-high frequency response ratios which, in the final analysis, is a major contributor to the phase distortion resulting in streaking. Depending upon the rise time of the window signal, an indication of "overpeaking" or excessively rapid cutoff may also be revealed.

Fig. 1(a) is a picture monitor presentation of a window signal with heavy positive streaking. (Polarity is given as positive since white-follows-white. If black follows white,

the polarity of streaking is negative.) It is important to understand that the degree of streaking observed on a picture monitor depends not only upon the monitor amplifier characteristics, but also upon ratio of brightness and contrast control settings. There is practically always some amount of visible streaking on a picture monitor when displaying a window signal (or any white bar on black background if the bar extends an appreciable length of a scanning line), and particularly where picture tubes draw grid current. The primary reason for development of the white window was so that a truly accurate measurement could be obtained from the CRO

presentation in quantitative terms.

The CRO presentation of the window of Fig. 1(a) at a horizontal rate time base is illustrated by Fig. 1(b). Note the excessive rate of time required for the white pulse to return to the blanking level. In this extreme case, it never quite makes it. Fig. 1(c) is the vertical-rate CRO display of the same signal. The white-going setup between the bottom of the white signal and blanking serves as an accurate indicator of percentage distortion. This defect is the result of excessive gain at low frequencies, and will cause an increase in "setup" level in addition to the streaking effect from the attendant low frequency phase

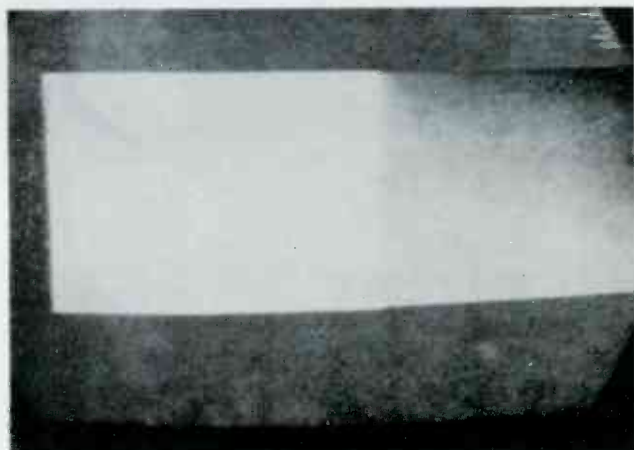


Fig. 1(a)—Monitor display of excessive positive streaking.

Fig. 1(b)—Horizontal-rate CRO display of positive streaking.

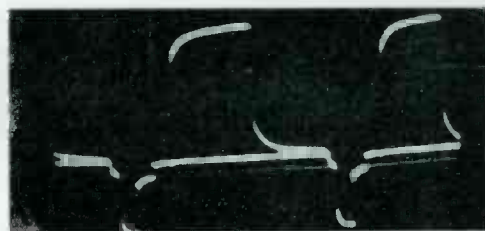
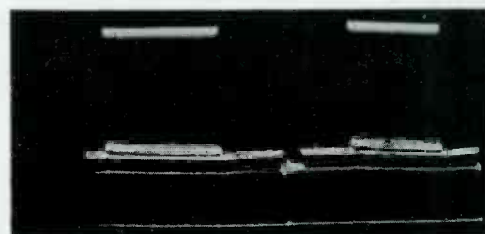


Fig. 1(c)—Vertical-rate CRO display of positive streaking.



By Harold E. Ennes
Maintenance Supervisor
WTAE, Pittsburgh, Pa.

shift. Such distortion is usually the result of a defective equalizer on long lines, or overcompensation of low-frequency compensation, or "tilt" controls.

Fig. 2(a) illustrates a picture monitor display of a form of streaking known as negative streaking. (b) and (c) of Fig. 2 are the horizontal and vertical rate (respectively) of the CRO presentation. This type of phase distortion is the result of insufficient gain at low frequencies—which may be taken as all scanning frequencies below approximately the tenth harmonic of the 15,750 cps line rate. It will normally be found in practice that the

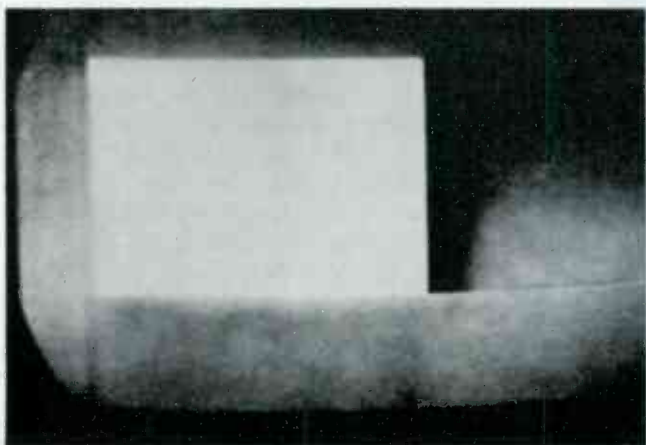


Fig. 2(a)—Monitor display of excessive negative streaking.

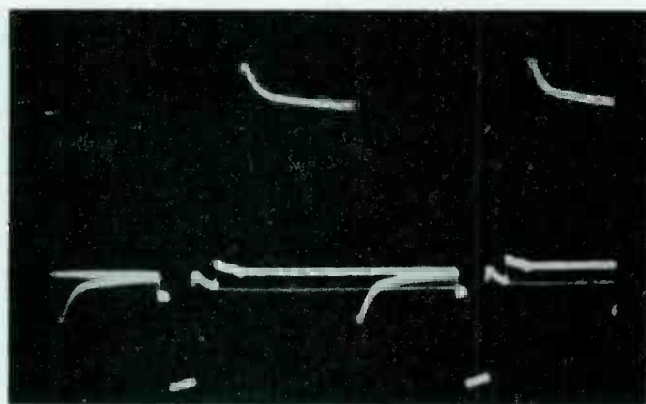


Fig. 2(b)—Horizontal-rate CRO display of negative streaking.

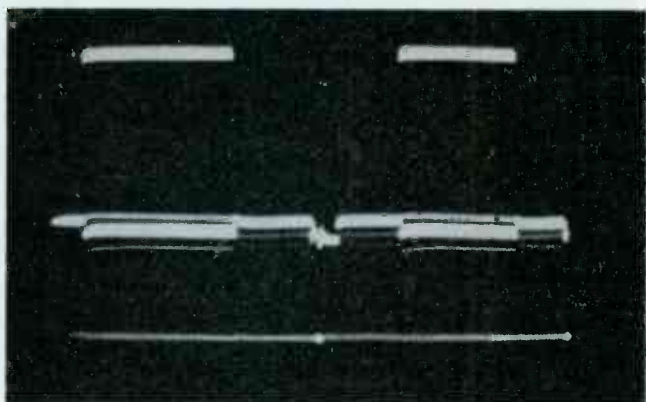


Fig. 2(c)—Vertical-rate CRO display of negative streaking.

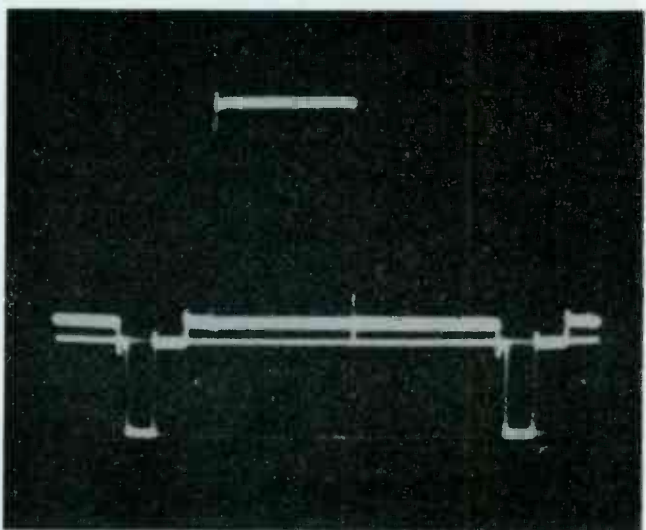


Fig. 3—Excessive high-frequency response (Horizontal rate).

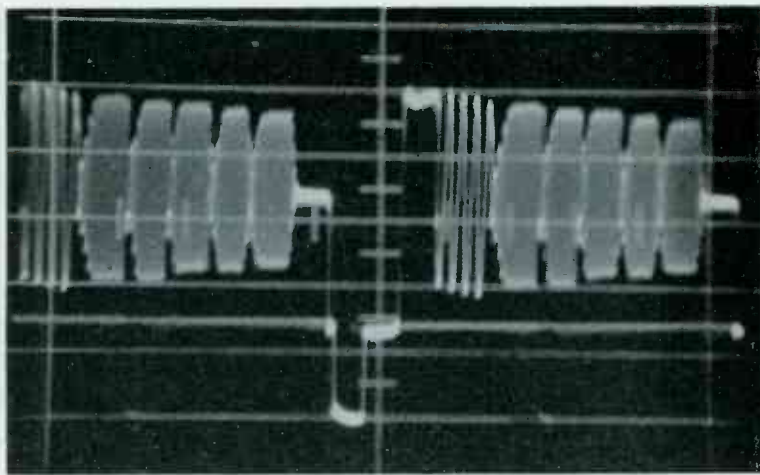


Fig. 4(a)—Keyed burst signal. Gradual roll-off at highs.

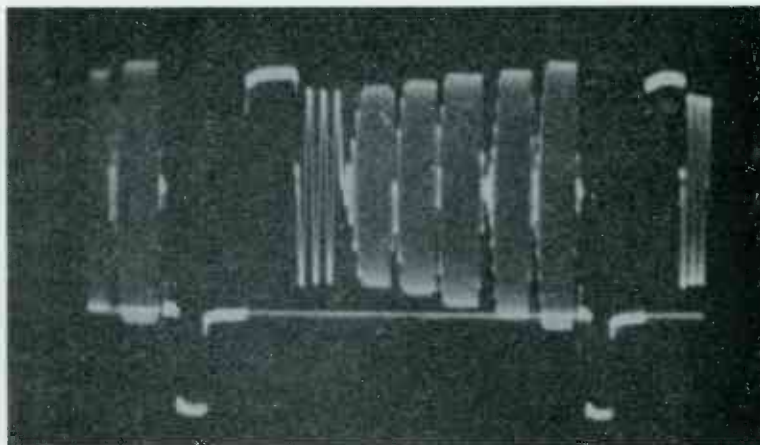


Fig. 4(b)—Gradual increase of gain with frequency.

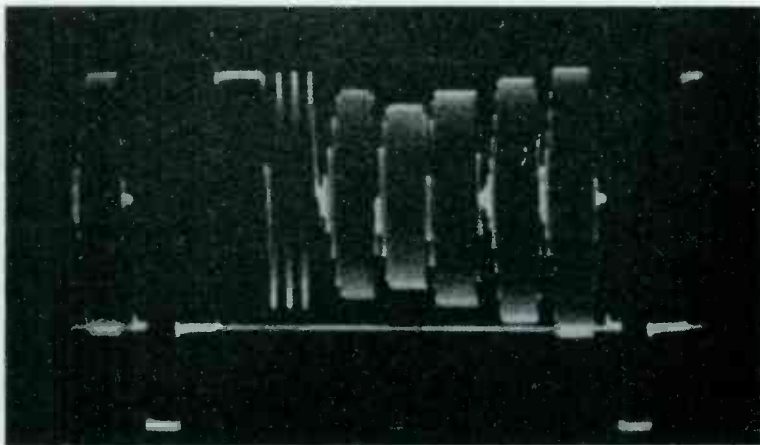


Fig. 4(c)—Loss of mid-frequencies (Hour-glass effect).

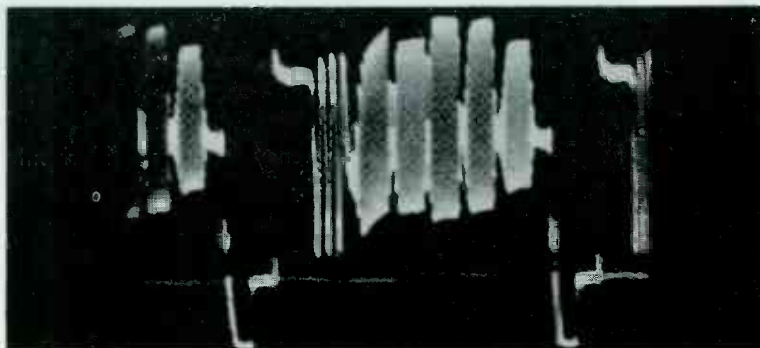


Fig. 4(d)—Harmonic distortion. Shifted axis.

loss of gain is occurring below the first few harmonics, or about 50 kc.

Fig. 3 is the CRO display of the window signal when low frequency response is normal, but overpeaking of the higher frequencies occurs. Such type of severe "edge effects" can also result when a video sweep shows a perfectly flat response over the normal video passband, but cuts off sharply immediately above this passband. This is the reason for using the square wave as a final check for video amplifier alignment as mentioned under the discussion of Fig. 2(C-3) of Part 1 of this article. (July issue of BROADCAST ENGINEERING.)

The Keyed Burst Signal

The keyed burst signal is the most convenient line or system check for frequency response from 0.5 mc to the upper limit of the system passband. The individual sine wave bursts should be read peak-to-peak in voltage or IRE units. The "setup" of course will change with attenuation of the burst frequency and should be disregarded in readings.

Fig. 4(a) illustrates a gradual rolloff with increasing frequency as would occur on a long unequalized line. For example, the attenuation at 4 mc of RG 11/U cable is 0.4 db/100 ft. Fig. 4(b) shows rising response usually the result of overpeaking. Fig. 4(c) is the "hourglass" display which can be caused by faulty equalization for a rolled-off response such as (a). In this case the higher frequency end is overequalized, and actually results in a picture much inferior to that obtained from the gradual rolloff of (a) because middle-frequency "holes" affect picture resolution to a drastic amount. This effect can also be produced by an open shield ground on one end of the coaxial cable transmitting the signal, or by faulty terminations. Fig. 4(d) illustrates a shifted axis along the individual bursts resulting from frequency-selective harmonic distortion which can be caused by overloads at selective frequencies or by overpeaking.

An actual loss of high frequency response or the axis shift effect is sometimes the result of deliberate overpeaking in an attempt to obtain a "sharp" picture. But if an "off-air" monitor were placed side-by-

Fig. 5(a)—Keyed video sweep on wideband CRO.

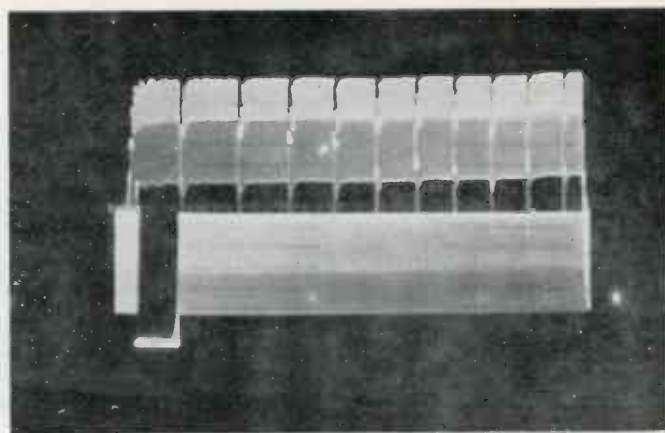
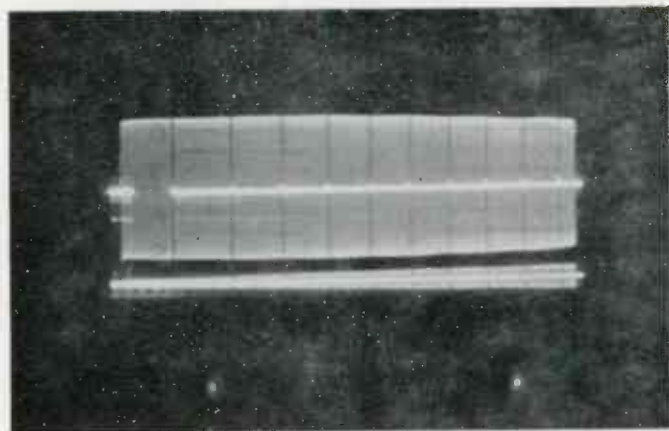


Fig. 5(b)—Detected keyed sweep.

side with a studio monitor displaying the overpeaked or overequalized signal, the modulation effects of the main transmitter and any studio-to-transmitter links (usually involving either microwave or equalized lines) would be most revealing. Most transmission using FM for video relay employs low frequency attenuation circuits to prevent excessive swings of the carrier frequency at the low video frequencies. This effectively limits the frequency excursion in the microwave receiver i. f. strip so that differential phase at 3.58 mc (color subcarrier) and any high-frequency sound subcarrier is within tolerable limits. As a specific example, the RCA TVM-1 STL transmitter uses 8 db attenuation at 60-cycles with gradually decreasing attenuation to 6 mc. The video is restored in the receiver restoration network. With any such networks, an overpeaked signal with the higher frequencies extending into the sync region will cause compression

or actual clipping of the highs. Restoration of the lower frequencies does not remove the high frequency compression which results in harmonic distortion in direct ratio to the amount of overpeaking.

The amount of compression, of course, is also dependent upon the peak-to-peak video level used at the modulator to obtain the 100% reference modulation. When this is held within the design limits of a particular system, the degree of compression from an overpeaked signal can be quite small. In this case, the major cause of severe edge effect is the ringing occurring in the main transmitter low-pass filter which employs a rapid cutoff above 4.18 mc. It is also known that when high frequency energy is appreciable (as is the case with sine-waves or keyed video sweeps), vacuum tube circuits, while passing lower frequencies at normal gains, can exhibit considerable overloading at these frequencies.

Keyed Video Sweep

Complete systems may be checked with keyed video sweep without removal and modification of clamper circuits as is required with straight video sweep.* Precautions in setup should be taken as shown by Fig. 5(a) which is the wideband CRO display through the keyer mentioned above. Adjust the video gain and blanking gain so that the swept video is above the blanking level. This is necessary since the detector (Fig. 5b) cannot discriminate between relative levels of video and blanking. Video sweep technique and interpretation is the same as that used for the keyed burst.

The Sine² Pulse

This technique essentially involves transmission of a pulse at line repetition rate with a half-amplitude diameter (abbreviated h.a.d.) equal to the time of either one or two picture elements. It is

*Schematic diagram of a simple keyer is shown in Fig. 10 of Article I, page 10, April '61, B/E.

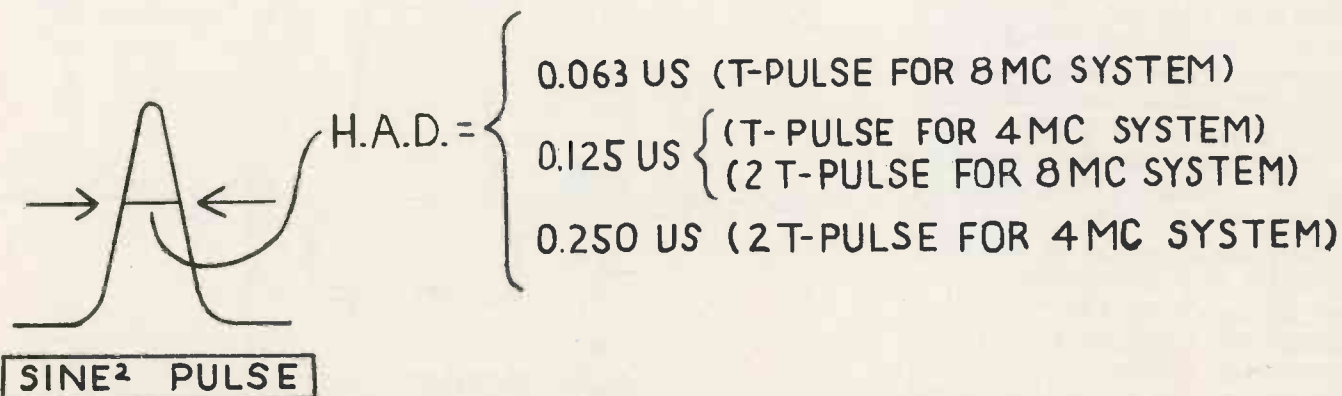


Fig. 6(a)—The Sine² pulse in terms of T and bandwidth.

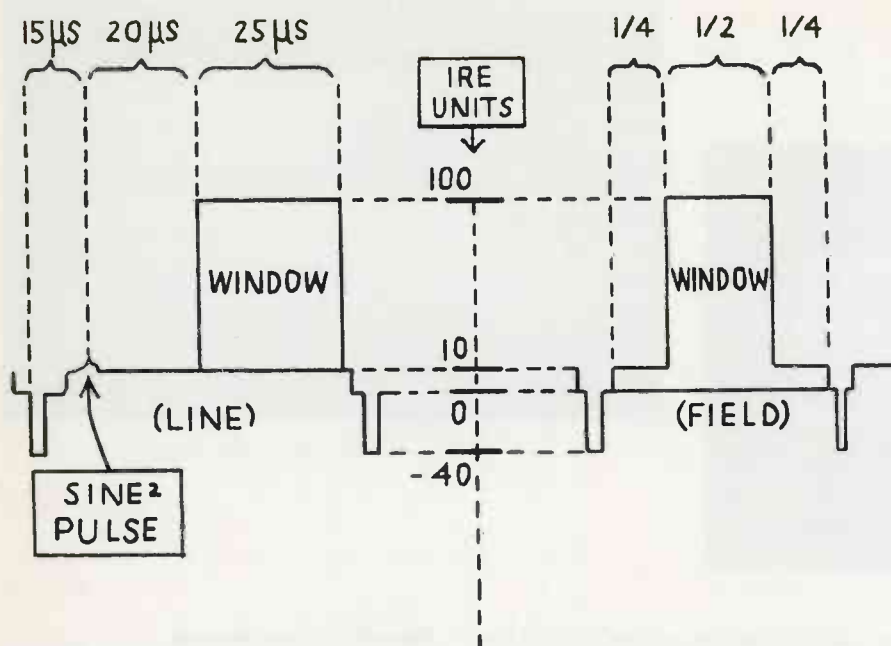


Fig. 6(b) — Horizontal-rate CRO display, Telechrome Generator.

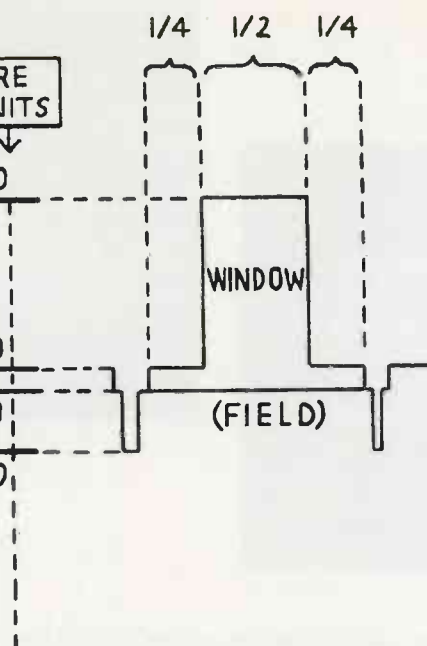


Fig. 6(c) — Vertical-rate CRO display, Telechrome Generator.

important to remember here that one TV cycle is equal to two picture elements. This is to say that the pickup tube scanning beam sweeping across a vertical black-to-white bar of the image on the photocathode (or target) will produce one cycle of the frequency representing the fineness of transition.

One cycle occurs in a time equal to the reciprocal of its frequency, for example:

$$1 \text{ cycle @ } 4 \text{ mc} = \frac{1}{4 (10^6)} = 0.250 \mu\text{s}.$$

which says that a black-to-white transition of a vertical bar with a width representing 4 mc will occur in 0.250 μs . But black is one picture element, and white is one picture element. Therefore a picture element of a 4 mc system is 0.125 μs (one alternation of the complete cycle). In the Sine² technique, a time duration of one picture element is given the symbol T, and a time duration of two picture elements (for the system bandwidth under test) is symbolized by 2T.

Fig. 6(a) shows the above definition in terms of T and system bandwidth. Fig. 6(b) is the horizontal timing of the Model TMC 1073-D2 Sine² Pulse-Window Generator manufactured by Telechrome, Amityville, Long Island, N. Y. The Sine² pulse appears as a thin vertical white line on the left of the raster immediately following blank-

ing, and the white window is on the right side, equally spaced vertically on the raster as shown by the field display of Fig. 6(c). This versatile instrument is frequently used by the major networks and by AT&T for system and line checks. The window signal has a rise time equivalent to that of the Sine² pulse.

The frequency spectrum of the Sine² pulse is such that at a frequency where $f = 1/T$ the spectrum amplitude remains at least 35 db under the fundamental. Thus for a

2T pulse of a 4 mc system (0.250 μs) no harmonics beyond 4 mc are present and the system is checked over the intended frequency range. Conversely, a T pulse (0.125 μs) will contain frequencies to 8 mc and will reveal the characteristics of a 4 mc system (such as the main TV transmitter) when being "hit" with the usual 8 mc signals from studio gear. The characteristics of the pulse are always the same and fixed by definition, just as for the VU meter in audio work. This appears to be a step in the right direction for obtaining a "standard" test signal.

The pulse measurement through a system under test is made in terms of the first lobe (negative) and second lobe (positive), by the ratios of the leading and trailing edge lobe amplitudes, by the h.a.d. and (with the combination window and pulse) by the relative heights of the pulse and window.

Fig. 7 illustrates the terminology used above. In general, the T-pulse measurement for a given complete system may be considered satisfactory if the h.a.d. is within 0.18 μs , the first (negative) lobe overshoot within 12% and the second (positive) lobe overshoot is within 8%.

An increase in attenuation such as that produced by a sharp cutoff above the desired passband will cause increased phase distortion below the upper limit of the passband. This is indicated by reduction in T-pulse height, increase in h.a.d. and

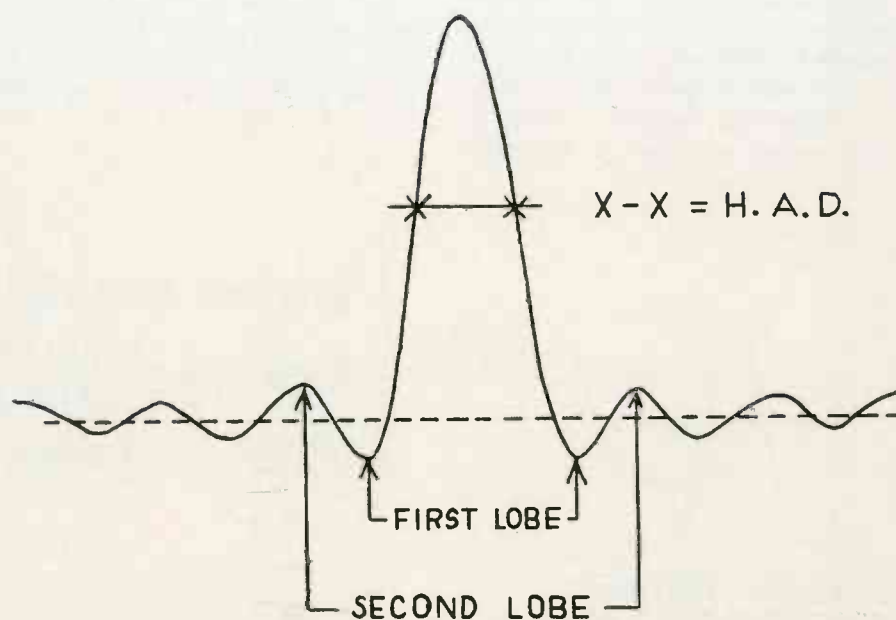


Fig. 7—Illustration of terminology used in preceding figures.

large amplitude ring on right-hand side of pulse. (Ref.: MacDiarmid; "Waveform Distortion in Television Links," *Post Office Electrical Engineers Journal*, July & Oct.—1959.)

Fig. 8(a) shows the expanded CRO display of a T-pulse through a 4 mc system with a sharp cutoff at about 5 mc. Fig. 8(b) is a 2T-pulse through the same system.

Relative low and high frequency gains are also indicated by the window/T-pulse amplitude ratios. Entire system analysis is based upon "K Factors" described in the aforementioned reference and in data supplied with the Telechrome Generators.

The Stairstep Signal

The stairstep signal consists normally of ten discrete steps of ten IRE units each for a total overall of 100 IRE units of video. The first step is at reference black level of 10 units. When this signal is passed through the unit or system under test, amplitude linearity may be measured conveniently in per cent. Black or white stretch, or compression, or "gray" non-linearity is immediately evident by a departure of each step from that at the system input.

A 3.58 mc (color subcarrier frequency) sine wave is inserted on the steps at an amplitude of 20 IRE units to measure differential gain and phase. This was shown on page 17 of the July B/E. In this case the amplitude was readjusted so that peak video was 100 IRE units. If not readjusted, the peak amplitude of the "white" sine wave would be 110 IRE units. (The amplitude of the sine wave is plus and minus 10 IRE units for a total of 20%.) Actually the latter is better practice as any tendency to "overload" at the high frequency spectrum is more evident, and the system should be able to provide this safety margin of 10% except through the modulation process at the main transmitter. Normally the video transmitter (or an external stabilizing amplifier) employs a certain amount of "white stretch" to compensate modulation non-linearity.

When the sine wave is superimposed on the steps, an external low-pass filter is used on the scope to display only the step signal for a measurement of low frequency amplitude linearity. A high-pass filter

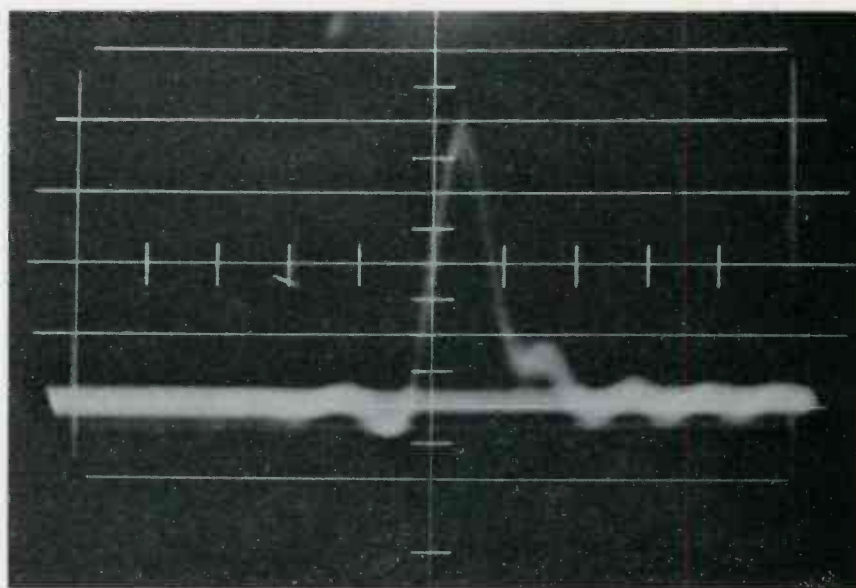


Fig. 8(a)—T-pulse through 4 mc system indicating high frequency delay greater than for low frequencies. Effect of cutoff filter at approximately 5 mc.

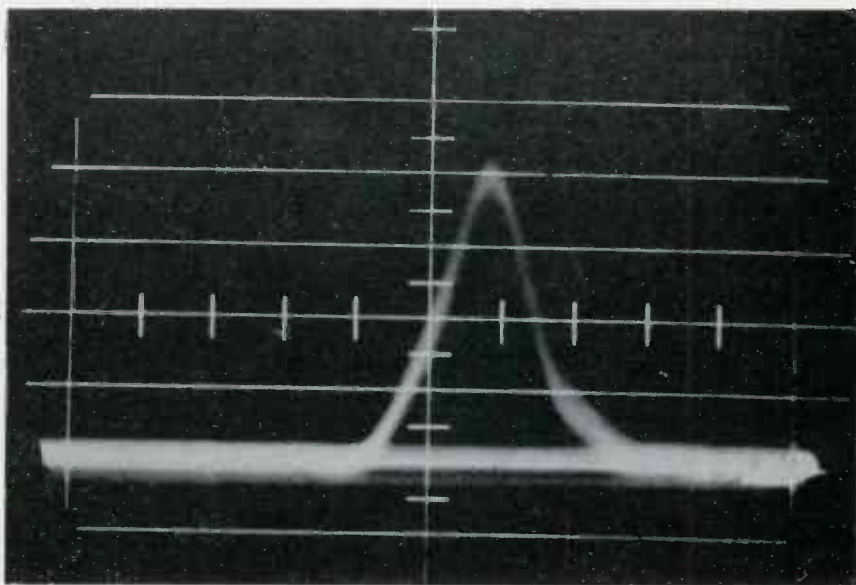


Fig. 8(b)—2T-pulse through same system. Satisfactory response to 4 mc.

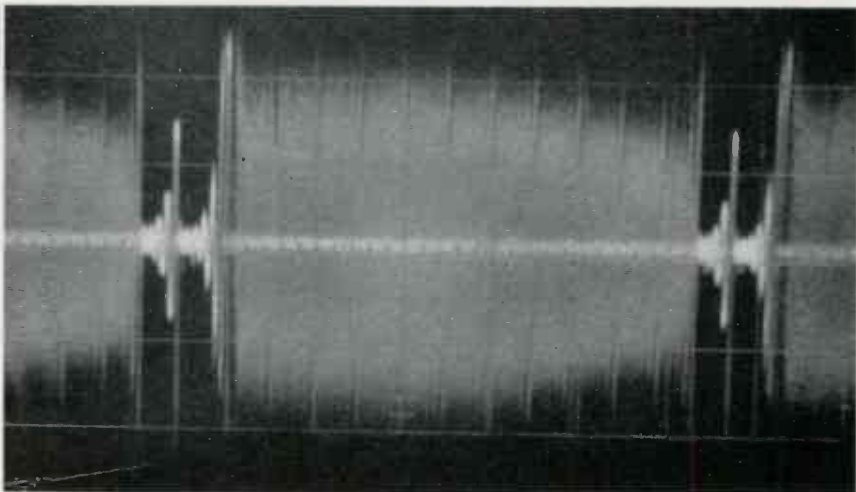


Fig. 9—Through high-pass filter.

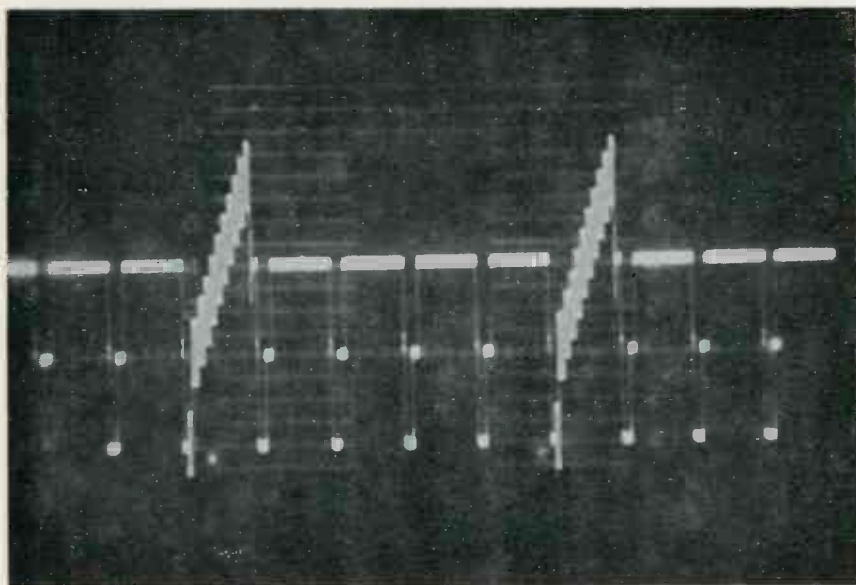
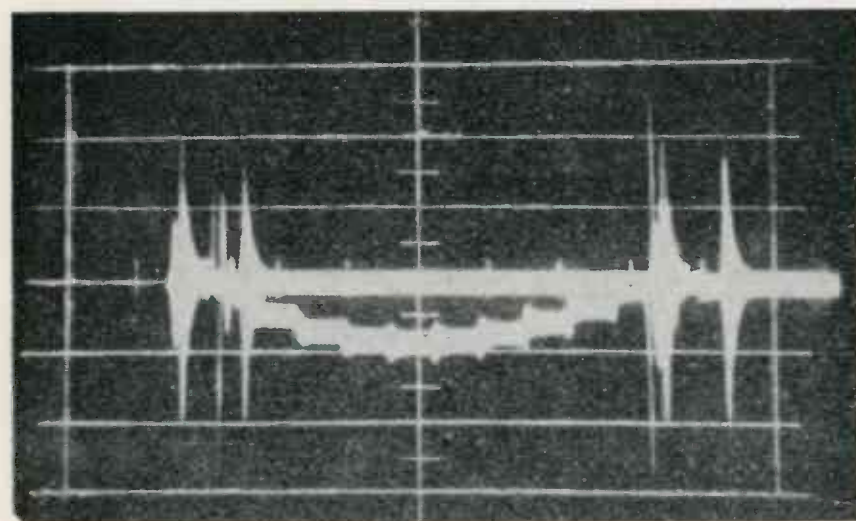
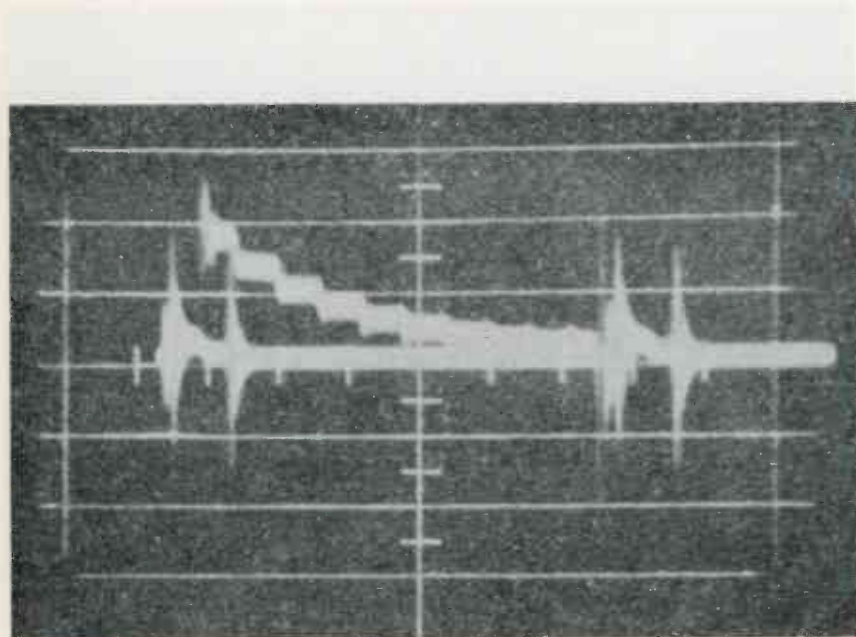


Fig. 10—One-in-five line staircase with 50% duty cycle.



Figs. 11(a) & (b)—Two possible traces at the output of a color signal analyzer.

is then inserted to pass only the 3.58 mc signal. Fig. 9 illustrates the display where considerable amount of differential gain is present with compression toward the "white" region and a smaller amount in the black region. The spikes which are due to the fast rise times of the individual steps provide a convenient marker between each stepped sine wave to indicate the step number associated with the sine wave. The peak-to-peak value of the lowest amplitude compared to the peak-to-peak value of the highest amplitude is the differential gain at 3.58 mc. For example, if the lowest amplitude is 80 IRE units and the highest is 100, the differential gain is 20%.

Differential gain is caused by excessive response at high frequencies, by lagging transconductance of vacuum tubes, or by low plate or bias voltages. In a complete system, coax cables and terminations must also be checked.

Differential phase is the measurement of any change in phase at a single frequency (usually 3.58 mc) as the amplitude varies between black and white. This requires special additional equipment such as the RCA Linearity Checker with variable duty cycle, and the RCA Color Signal Analyzer.

Fig. 10 shows the output of the staircase signal adjusted to occur once in every five lines. Measurements are usually taken at 10%, 50% and 90% duty cycle. This also shows the pedestal adjusted for an ac axis equivalent to an approximately 50% duty cycle. The output of the system is then fed to the measuring device to determine the phase shift in degrees. Fig. 11 is a typical trace obtained from the device named above. In 11(a), the right-hand edge of the trace has been adjusted to the reference line by means of a positioning phase control in the Analyzer. A calibrated control is then adjusted to bring the left-hand edge of the trace to the reference point, and the differential phase in degrees is read directly from the calibration on the control. In some cases the trace will appear as in Fig. 11(b). In this instance, the positioning phase control is adjusted to place both edges at the reference, then the calibrated control is used to position the center on the reference.



MULTI-V* FM ANTENNA

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"Boston's Music Stations"



AM 1330 / FM 102.5

January 22, 1960

Andrew Corporation
P.O. Box 296
Westwood, Massachusetts

Attention: Mr. John Wyman

Gentlemen:

As you know we recently purchased one of your six-bay Multi-V FM broadcast antennas, and over 1000 feet of your H-1 Heliax for use on our new FM installation on the WBZ-TV tower.

Our choice of the antenna was based on our previous experience with antennas of this type, which have always performed very well. We are happy to say that our new antenna and co-ax are exceeding our best expectations, and giving excellent coverage for both our main channel and our multiplex transmissions.

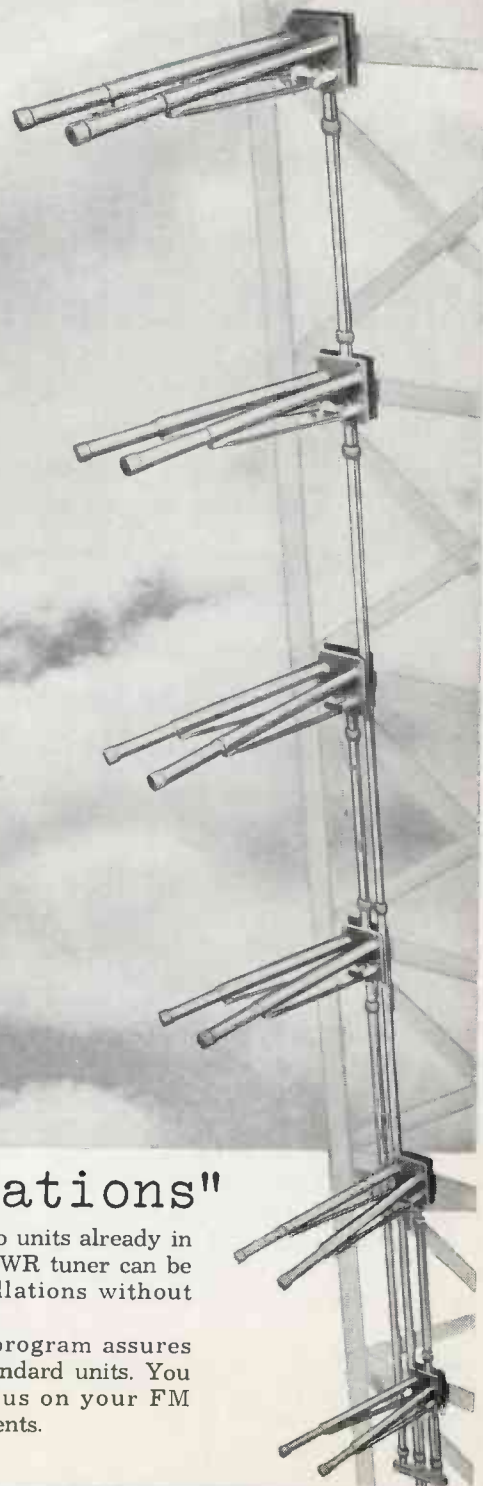
We do not hesitate to recommend highly this Multi-V Antenna to any broadcaster proposing new or improved FM facilities.

Yours truly,
Richard L. Kaye
Richard L. Kaye
Station Manager

RLK:chn



Also Special Background Music Via WCRB Music Service Inc.



"exceeding our best expectations"

The ANDREW Multi-V is the standard of the industry. Over 353 Multi-V units have been installed to date, accounting for more than 50% of the stations presently licensed. Installations have been made in all climates and service is uniformly acclaimed both for standard and multiplex operation. De-icers are available for use when icing conditions

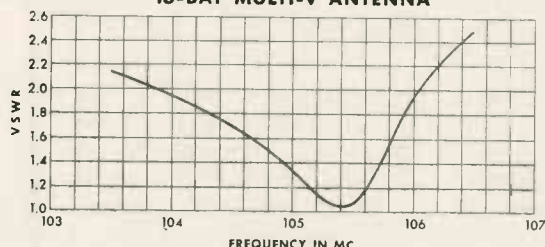
occur and can be added to units already in service. Similarly, the VSWR tuner can be added to existing installations without modifying the antenna.

A new warehousing program assures quick deliveries of all standard units. You are invited to consult us on your FM antenna system requirements.

WRITE FOR NEW FM ANTENNA CATALOG

Measured VSWR on a 16-bay production unit. Note bandwidth. VSWR tuner, Type 19893, is available for tuning out tower effect, thus, assuring optimum performance and eliminating need for field tuning individual bays.

16-BAY MULTI-V ANTENNA



HELIAX

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FORENSIC ENGINEERING

The increasing degree of complication in radio proposals and hearings today requires an engineer who is a quasi-lawyer, and in turn a lawyer who is a quasi-engineer. In fact many lawyers are former engineers to whom the legal maze presents the same fascination that a complicated directional design does,



*By Quayle B. Smith
Communications Lawyer
Washington, D. C.*

ABOUT ten years ago the then chairman of the FCC, in addressing a Federal Communications Bar Assn. banquet gathering, remarked that if it had not been for the establishment of directional antenna systems, the Association could have held its meeting in a phone booth. It might have required an oversized phone booth, but the basic truth of the observation could not be challenged.

In the 1920's, it was realized that chaos would inevitably result if broadcasters were to operate their facilities without any governmental regulation whatsoever. Accordingly, the Congress created the Federal Radio Commission which set about the task of bringing order out of confusion. Nearly 35 years later, the battle still rages.

As of Nov. 1, 1961, there were 3601 standard broadcast stations in the United States squeezed into the 535—1605 KC portion of the radio frequency spectrum available for standard broadcast use. Needless to say, it has taken a great deal of squeezing, and some very skillful squeezing, to accomplish this result.

Notwithstanding an apparent abundance of existing stations, applications daily pour into the FCC seeking new facilities. In Washington, where soothsaying almost has a professional status, no one is willing to risk his reputation on even a guess as to where the saturation point lies.

Chances are, it will be economic considerations rather than engineering considerations which will ultimately halt the establishment of new broadcasting facilities. Certainly, with the resourcefulness of the radio engineering allocation specialist at our disposal, many, many more new facilities can and will be established.

Nowadays, when separate disciplines come together, a term is coined to describe the inseparable functions of the merged disciplines. When one of the disciplines has to do with legal advocacy, the expression "forensic" is used. Thus, the presentation of medical principles in litigation comes under the category of "forensic medicine." Accordingly, for the purpose of this article, the writer uses the expression "forensic

engineering" to describe the combined activities of the communications lawyer and the consulting engineer in achieving the establishment of new and improved broadcast facilities through the administrative processes of the FCC.

The body of rules and regulations governing the broadcast service presents a complex picture to the individual or group of individuals seeking to establish a new broadcast station, and unless he is an unusually qualified prospective broadcaster, he will seek the services of specialists in communications. He may first contact a communications lawyer or he may contact a consulting radio engineer. But it is the consulting radio engineer who must first determine whether there is a frequency available for the proposed facility.

There is no quick, easy way for the consulting engineer to make the determination of availability of a frequency. Because of the large number of existing operations and pending applications for new facilities (nearly 900 as of Nov. 1, 1961), all of which must be considered in

the searching process, this important step can be quite laborious. Frequently, preliminary directional antenna designs must be resorted to in order to squeeze a proposed facility into the desired area. The consulting engineer has at his disposal all of the information he requires—up-to-date data on existing stations, accurate and complete information on all pending applications, and daily reports of new applications filed with the Commission. Thus equipped, he is prepared to proceed with a task that may or may not produce the desired result.

The consulting engineer has a great responsibility to his client. It is upon his say-so that the prospective broadcaster will or will not proceed with investing his funds and time in a project. The expenditure of many thousands of dollars and hours of time may be fruitless simply because of an oversight in considering some factor in making the frequency search. Because of the general high level of competency of the consulting engineer and his thoroughness in researching, the communications lawyer may, with utmost confidence, rely upon the consulting engineer's findings and thereby form the basis upon which he may advise his client of the feasibility of proceeding with the preparation of the application for the proposed facility.

Usually, it is not possible for the consulting engineer to come up with a simple solution to the prospective broadcaster's problem, that is, a solution which provides an available frequency for the desired operation which would not cause objectionable interference to any existing station or pending application, and which would not receive such interference as would violate the Commission's Rules and Regulations. Assuming the usual case, the client, the communications lawyer and the consulting engineer must together determine the feasibility of the project in the light of the engineering considerations developed by the consulting engineer in his preliminary studies.

Even employing sophisticated directional antenna arrays, it is often impossible to develop a proposal which would not cause some objectionable interference to existing stations or pending applications. If the

proposal would cause interference within the normally-protected or interference-free service area of an existing station, the prospective broadcaster will, in all probability, be confronted with a hearing on his application before the FCC for the purpose of determining whether the need for the proposed facility outweighs the loss of service which the existing station would suffer. Due process considerations guarantee to an existing station the right to a hearing if objectionable interference would result from the proposed operation. That is to say: if the existing station formally presents its objections to the FCC, the Commission cannot legally sanction the establishment of an encroaching service without affording to the existing station an opportunity to show, at a hearing, that its license should not be modified by virtue of a diminishment of its service area.

Head-on conflicts probably constitute the bulk of the Commission's hearing activities. So-called mutually-exclusive applications must, by law, be considered in one proceeding for the simple reason that where only one of several applications can be granted—because of prohibitive mutual interference—the Commission must in a comparative proceeding determine which of the mutually-exclusive proposals would best serve the public interest.

The third type of FCC hearing which is sometimes necessary on applications for new and improved facilities involves only questions of compliance with domestic rules and regulations and treaty considerations. For example, the Commission may require a hearing to determine whether the public interest would be served by the grant of a new service which would be subject to interference affecting more than 10 per cent of the population within its normally-protected primary service area. Another example of this type of hearing is where an unusual or complex directional antenna array is proposed. Although the Commission seldom compels a hearing where the sole issue would be the question of proof of the feasibility of an antenna design (the consulting engineer and Commission staff engineers usually can informally resolve any such questions) an existing station may file

with the Commission an objection urging that the proposed antenna array will not function as proposed, thus, specified tolerances cannot be maintained and accordingly the protection which is to be afforded the existing station cannot be achieved. If the existing station makes out a persuasive case (on the basis of an affidavit of *his* consulting engineer) the Commission will designate the application for hearing and afford the existing station an opportunity to be heard, or more precisely, an opportunity for his consulting engineer to be heard.

In each of the three types of hearing on applications for new or improved facilities, the matters in issue can only be proved through the use of the testimony of a qualified consulting engineer. Because most hearings are adversary proceedings, all of the techniques of trial are employed. However, cross-examination of consulting engineers, as expert witnesses, seldom achieves any dramatic heights.

For the purpose of illustrating forensic engineering in practice, we will assume that there are pending before the Commission the application of A Broadcasting Co. and B Broadcasting Co., each requesting the use of the same frequency in different communities. Although mutual interference is expected, there has been no determination of whether the interference is mutually destructive to the point where the applications are mutually exclusive. Also, A Broadcasting Co. proposes the use of a directional antenna array which is a little unusual. Upon these conditions, the Commission would, in its notice designating the applications for hearing, specify issues in the following style:

To determine the areas and populations which would receive service from the proposals of A Broadcasting Co. and B Broadcasting Co., respectively, and the availability of other primary service to such areas and populations.

To determine the nature and extent of the interference, if any, that each of the instant proposals would cause to and receive from each other and all other existing standard broadcast stations, the areas and populations affected thereby, and the availability of other primary services to the areas and populations affected by interference from any of the instant proposals.

(Continued on page 22)

TOP HOP EDUCATIONAL TV

*By Peter K. Onnigian
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A two hop dual television microwave system is described, with some unique features. The circuit has one hop which is 55 miles and the other 27 miles. Measured performance on signal-to-noise of the video exceeds 46 DB, while the audio exceeds -57 DB. The system utilizes two audio channels, one of which is used for intercom while the other carries program audio.

EARLY in 1960 California educational TV stations KVIE, channel 6 in Sacramento and KQED, channel 9 in San Francisco decided to link their facilities. Such a tie-up of California's only educational TV stations could accomplish a great deal in the way of programming for the viewers of both stations. The system was financed by a grant from the Fund for Adult Education and the system is licensed to KVIE. (Central California Educational TV.)

The System

The system is shown in Figure 1. It provides for two simultaneous microwave systems. One channel of video and two channels of audio go from Sacramento to San Francisco. At the same time, one video and two audio channels go from San Francisco to Sacramento. The two

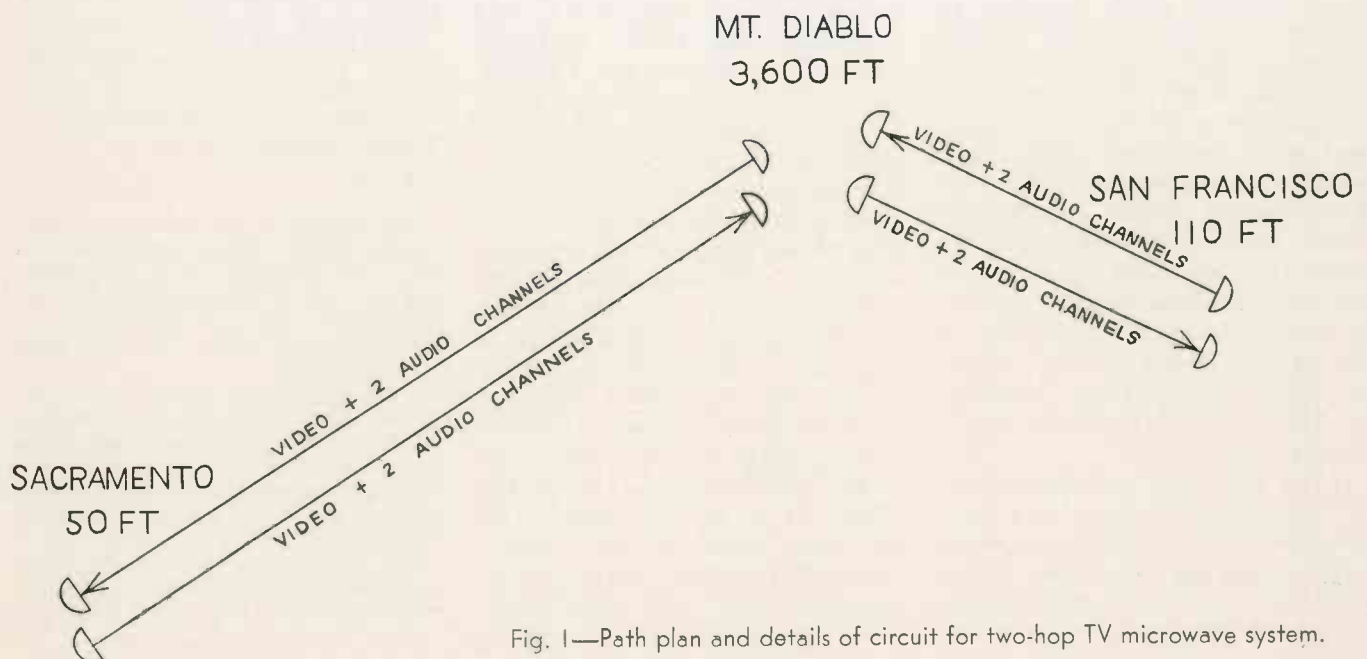


Fig. 1—Path plan and details of circuit for two-hop TV microwave system.

MICROWAVE SYSTEM

systems are independent of each other. They are common only in their physical locations.

A repeater is located at Mount Diablo, which demodulates video but not audio. The hop from Sacramento to Mount Diablo is 55 miles and the hop from San Francisco to Mount Diablo is 27 miles.

The system utilizes the 2,000 Mc band. It has been shown that propagation reliability from Sacramento to Mount Diablo is not good on 7,000 Mc. (1) The 55 mile hop starts at 50 feet above sea level at Sacramento and goes to 3,600 feet at Mount Diablo. The KQED elevation is 110 feet above sea level. The area between Sacramento and Mount Diablo is subject to wide variations of barometric pressure, non-linear temperature with height and humidity changes. In short, the refractive index is non-uniform along the path during the summer, early spring and early fall. (1) 7,000 Mc equipment in this same path has shown fading depths of up to 46 DB. The propagation reliability of 2,000 Mc equipment is known to be superior to 7,000 Mc in this geographical area, plagued as it is with temperature inversion and other causes of abnormal refractive indices. (2, 3)

The propagation of microwave energy is affected by the inverse square law losses, the dielectric constant of the atmosphere between transmitter and receiver antennas, diffraction, diffusion, scattering, earth and water reflections and other obstacles. (6) Most of these factors are outside the control of the user; however the system must be engineered to take all these matters into consideration for best possible operation.

TABLE 1 — CIRCUIT MEASUREMENTS

Between Sacramento and Mount Diablo	Calculated	Measured
Transmitter Output	+ 30 DBM	+ 30 DBM
Transmitter line loss	— 2.1 DB	— 2.4 DB
Isolator loss	— 1.0 DB	— 0.9 DB
Transmitter antenna gain (10 Ft.)	+ 33 DB	N.M. *
Space loss (55 miles)	— 133.5 DB	N.M. *
Receiving antenna gain (10 Ft.)	+ 33 DB	N.M. *
Receiving antenna line loss	— 1.26 DB	— 1.5 DB
Received signal, input to receiver	— 43.86 DBM	— 40 DBM
Between Mount Diablo and San Francisco		
Transmitter Output	+ 30 DBM	+ 30 DBM
Transmitter line loss	— 2.73 DB	— 3.00 DB
Isolator loss	— 1.00 DB	— 0.80 DB
Transmitter antenna gain (6 Ft.)	+ 27 DB	N.M. *
Space loss (27 miles)	— 127.5	N.M. *
Receiving antenna gain (6 Ft.)	+ 27 DB	N.M. *
Receiving antenna trans. line loss	— 1.25 DB	1.4 DB
Received signal, input to receiver	— 48.48 DBM	— 48.00 DBM
Signal required for 40 DB P/P S/N	— 56 DBM	— 60 DBM

Note: *N.M. = Not Measured

Differences between the two systems, as measured, was approximately 2 DB overall.

As the micro-wave frequency increases, the space attenuation increases. The difference between 2,000 Mcs and 7,000 Mcs for the

same distance is an 11 DB greater loss for 7,000 Mcs. In addition, on the 55 mile hop, the increased attenuation of 7,000 Mcs. propagation

due to light rain is 12 DB making a total path loss of 23 DB higher for 7,000 Mcs. While the path loss can be made up with 10 foot dishes on the higher frequency, the beam width would be less than 1 degree, thus posing antenna mounting problems. Further unsurmountable problems will be caused by great fading depths due to extreme sharpness of transmitting beam, and the same sharpness in the receiving antenna. (4).

Free space propagation characteristics require that there be Fresnel Zone clearance to avoid the reduction in signal level which results from destructive interference. Free space field strength is a convenient reference for comparing signal strengths over a microwave path. The first Fresnel Zone is defined as points whose path difference between the two antennas (transmitting and receiving) is one half wavelength. Free space values equal to 0.6 first Fresnel Zone are recommended for greater received signal strength together with minimum fading. (5)

Fading

Variations in received signal strength is called fading, and results from two main causes: (5) beam bending and (6) multi-path interference. Beam bending is caused by variations in the refractive index of the air between the transmitting and receiving antenna. This index is

made up of a combination of atmospheric pressure, temperature, and humidity. There is a normal index for all elevations, which may be defined as the square root of the dielectric constant, of the order of 1.

The refractive index may change over a period of hours, minutes or several seconds. A long microwave path may have in one area an air mass with sub-standard refraction, causing upward bending. In another part of the same path there may exist an area of refraction greater than normal, bending what energy is there, downward. This diffraction of energy upward or downward due to temperature, humidity or pressure gradients, is known as inversion fading.

When the air is turbulent and well mixed, due to winds or storms, propagation is usually good, because the refractive index is fairly uniform throughout the path. It is also good in the winter months when the air is cold and dry. However, fading occurs in some parts of the country on calm days or evenings in the spring and summer months. Fading also occurs in the late evening to early morning hours when cooling of the earth causes temperature inversions, and when a micro-wave signal passes through a layer of fog. A sharp point of discontinuity occurs at the top of the fog layer where the humidity drops from 100% in the fog to a much lower percentage

in the clear, just above it. The temperature *above* the fog is several degrees higher than *in* the fog.

There are currently three microwave bands open to TV broadcasters for TV STL use. These are the 2,000, 7,000 and 13,000 Mcs bands. It is therefore imperative that the operation be selected in the band that gives best performance, if refractive index problems (fading) exists in the geographical area.

Equipment

Sarkes Tarzian 2,000 Mc microwave equipment was chosen by KVIE to do the work required of this system, and type MT-1C 10 watt long range transmitters are used. The system uses 10 foot fixed parabolas between Sacramento and Mount Diablo. Six foot dishes are used between Mount Diablo and San Francisco. All equipment is housed indoors. Co-axial cable 7/8-inch in diameter connects the dishes with the transmitters and receivers. The longest transmission line runs are on the Mount Diablo to San Francisco receiver and transmitter and are 138 feet long.

The Sarkes Tarzian equipment permits mounting all electronic equipment in racks indoors for complete weather protection and ease of adjustment and maintenance. Load isolators are used to reduce the effect of "klystron pulling" by the long co-axial transmission lines on all four transmitters.

TABLE 2 — MEASURED TEST RESULTS KVIE - KQED MICROWAVE SYSTEM

TYPE OF TEST	FROM	TO	Audio		VIDEO
			CHANNEL 1	CHANNEL 2	
Video signal to noise, P/P.....	KVIE	KQED			48.6 DB
	KQED	KVIE			46.0 DB
Video, S/N P/P, Round-Robin*.....	KVIE	KVIE			41.0 DB
Audio, noise	KVIE	KQED	— 60 DB	— 62 DB	
	KQED	KVIE	— 57 DB	— 58 DB	
Audio, noise, Round-Robin*.....	KVIE	KVIE	— 54 DB	— 55 DB	
Audio distortion, @ 1 KC.....	KVIE	KQED	0.65 %	0.8 %	
	KQED	KVIE	1.1 %	1.15 %	
Audio distortion, Round-Robin*.....	KVIE	KVIE	1.3 %	1.4 %	

* "Round-Robin" circuit consists of four hops totalling 164 miles, of which two hops are 55 miles each. Sarkes Tarzian Inc. type MW-1C microwave equipment used, (2,000 Mcs)

The system uses 6.2 Mc and 6.8 Mc sound sub-carriers. Equipment for this is mounted in the racks at Sacramento. Since there is no audio demodulation at Mount Diablo, sub-carrier equipment is not used there.

The microwave equipment in San Francisco is at two separate locations. The micro wave transmitter and receiver, together with their respective parabolas, are mounted on top of a six-story industrial building just west of the San Francisco Bay Bridge. This building supports a permanent electric advertising sign. The large metal frame work of the sign supports the two six-foot antennas. An equipment shack built on top of the building houses the transmitter and receiver, and the subcarrier receivers and transmitters are mounted in the control room of KVIE, some 250 feet away. RG11/U cable is used to bring video with sub-carrier signals into the control room for demodulation. The same system is used to carry video from the control room (with two sub-carriers) up to the micro-wave transmitter, 250 feet away. There is no degradation of either video or audio with this arrangement. Less than 1 DB of sub-carrier RF is lost in this process, easily made up by increasing the sub-carrier RF level output.

One unusual problem existed with this roof-top installation. There was a potential difference of several volts in the ground system between the electric sign (where the m/w equipment obtains its power) and the KVIE control room. To prevent ac hum from getting into the video, the entire microwave installation was "lifted" from the roof building electrical ground. This meant insulating the transmission line and dipoles from the electric sign—no easy task. However, as the measured specifications show, there is no hum problem in the system.

Transmitters

The transmitter output tube is a klystron, which gives a 10-watt RF output. This SRL7-G tube operates between 1990 Mc and 2,100 Mc and using 10-foot parabolas in the Sacramento to Mount Diablo 55 mile hop, the effective radiated power output is 20,000 watts. The klystron can handle a video bandwidth of 8 Mcs, assuring excellent NTSC

color operation, simultaneously with two channels of 15 KC audio. Figure 2 shows the entire rack equipment with the receiver at the top, followed by the transmitter modulator panel and then the klystron panel. Below this is a transmitter operational log panel. The regulated power supplies are on the bottom two panels.

The Sarkes Tarzian microwave transmitter has two built-in test signal sources. A linear sawtooth, whose amplitude and repetition rate can be varied, and a 15,750 cps key pulse, which allows tests with the clamping circuits to operate normally are provided. These test signals allow complete system checks without need for a video source. They are of particular use in multi-hop systems, especially at repeaters where video signals are not available. Rapid path signal-to-noise measurements can be made with this built-in test source, during initial alignment and maintenance tests. Convenient test check points are located throughout the equipment for servicing.

Silicon rectifiers are used in the two power supplies and all supply voltages are regulated.

Receivers

Sarkes Tarzian Inc. type MR-2D microwave receivers are used in this system. The measured noise figure is approximately 8 DB. Complete metering is provided to measure incoming RF signal level in DBM, crystal current and discriminator output.

The method of incoming RF level measurement is simple. The RF level indication is taken from the first limiter grid and measures relative RF input. A calibration card is shipped with each receiver allowing the user to read microvolts of input directly. This is a very useful feature since in all other microwave receivers the RF level indication is taken from the second limiter, or after an IF gain control.

The local oscillator in the receiver is a 6BM6 external cavity klystron. Local oscillator injection is measured by reading the crystal current.

A very unusual feature of the receiver is lack of AFC circuitry. The IF center frequency is 130 megacycles and it is 20 Mcs wide. The transmitter klystrons are automatic frequency controlled by ther-



Fig. 2 — Sarkes Tarzian M/W Equipment, Model MWF-1C, long-range microwave relay.

mal control, and AFC is not needed in the receiver.

Measured Performance

The requirements of this system are typical of most TV microwave systems. The video signal-to-noise, together with amplitude linearity, must be good. The specifications for

video signal-to-noise were placed at 40 DB, measured on a wide band scope flat out to 6 megacycles. The video amplitude linearity on a standard stair step signal must be good and a target of 5% was set. Since the system was not intended for color, no color type measurements were made. However, differential gain measurements using stairsteps indicated excellent performance. Multi burst signals were used to measure frequency response.

In addition to the normal video and program audio channel, this system has a voice communications channel. It was mandatory that this inter-com channel not degrade the video and audio in any way. Therefore a crosstalk requirement of -55 DB was set between the two audio channels. Further, either audio channel had to be at least -40 DB down in the video channel. RF signal level measurements were made with a H-P 614A signal generator, while an H-P audio generator and distortion analyzer were used for the audio tests. All channels were in operation while the channel under test was being measured.

The video signal-to-noise was measured in the following manner. A staircase 1.4 volt peak-to-peak video signal was fed into the system at Sacramento. Video gain at the Mount Diablo repeater was adjusted for normal operation. The receiver video gain at San Francisco was adjusted for 1.4 volts output, and measured on a Tektronics 524 scope in the "wide" position. The input to the microwave transmitter at Sacramento was then terminated, and the signal resulting from this termination was then measured on the scope on a peak-to-peak basis. The ratio of the two voltages was then converted into DB. If it is desired to measure in terms of peak signal to RMS noise, then 13 DB should be added to the foregoing measurement. During the measurement, 1,000 cps tone was fed into the program channel, and the intercom channel was in use, to determine crosstalk between audio sub-carriers and the video channel. None could be seen, either as a beat or audio banding. The same procedure was used to measure the video S/N from San Francisco to Sacramento.

The same general principle is

used in the audio noise measurements, except that a 1,000 cycle tone is used as the audio signal, and an audio distortion analyzer is used to measure the noise. During the measurements test pattern video was being transmitted, and the other audio channel was in normal use.

The results of the test measurements are shown in Table 2. The system was patched over at San Francisco and the signals returned to Sacramento for a complete round-robin four hop test. These results are also shown. The discrepancy in these latter tests versus the dual hops is due to unknown degradation in patch over facilities. Crosstalk between audio channels could not be measured because it was below the noise level of the individual channel. No fading was observed over the six-week period during which the system was under observation for fades.

Due to the mountain range between Sacramento and San Francisco, a mid-hop repeater was required. Mount Diablo was chosen

because of its accessibility, power, buildings, tower support, etc. The equipment was housed in the ex-KOVR-TV transmitter building.

This mid-hop repeater broke the total path into two hops, one 55 miles long and one 27 miles. The design of dish sizes, allowable transmission line losses, etc., were calculated for this path. The path engineering is shown in Table 1, and the measured data is also shown for comparison.

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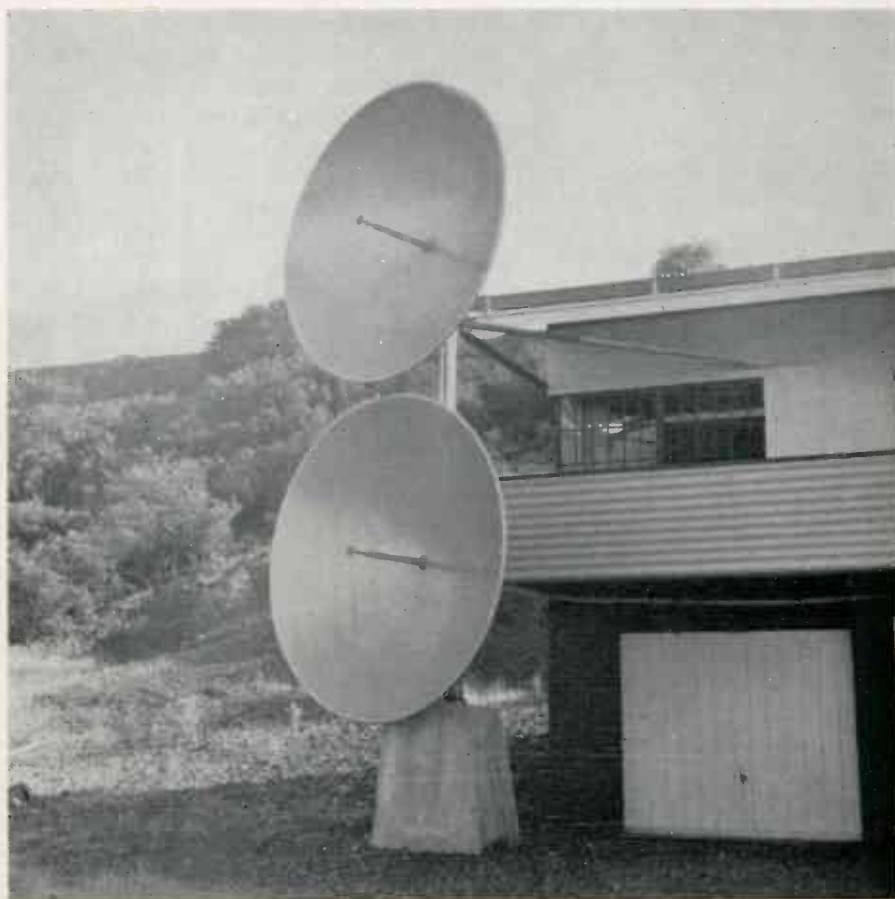


Fig. 3 — The end and the beginning of the circuits.

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(Continued from page 15)

To determine whether the interference received by each instant proposal from the other proposal and from any existing stations would affect more than 10 per cent of the population within its normally protected primary service area in contravention of Section 3.28(c)(3) of the Commission Rules and, if so, whether circumstances exist would warrant a waiver of said Section.

To determine whether the directional antenna system proposed by A Broadcasting Co. can be adjusted and maintained as proposed and whether the performance of the antenna system would be in accordance with the Commission's Standard Broadcast Technical Standards.

Prior to the hearing, the communications lawyer and the consulting engineer will confer and review the issues which the Commission has specified in its notice of hearing. Together they will determine what documentary evidence must be prepared by the consulting engineer in order to meet the burden of proving each of the matters raised in the hearing issues.

Assuming that our pair of communication specialists—the lawyer and the engineer—are representing A Broadcasting Co., the preparation for hearing would involve the preparation of such evidentiary data as would establish the areas and population to be served; the interference which would be caused to applicant B Broadcasting Co. and to existing stations, broken down into areas and population involved; the interference which would be received by A Broadcasting Co., and such data as would establish the feasibility of the proposed directional antenna array.

The nightmare of all consulting engineers is the preparation of an exhibit showing the availability of other primary services to the area and population to be served. In nearly all parts of the country, numerous existing stations provide primary service to all or part of any proposed service area. This showing usually results in such an interweaving of service contours, the nomenclature "spaghetti map" quite naturally came to be a term of art in describing such exhibits. But, as the issues require a showing, the consulting engineer simply *has* to lose sleep.

The degree of detail which will be required depends upon the facts of the particular situation. If, for example, interference will be caused to existing stations, studies must be made and exhibits prepared showing the basis for the operations and the existing limitations of the interfered-with stations. The consulting engineer will rely upon Commission records, conductivity maps and measurements made in connection with other studies in the areas involved. If there is a question as to the accuracy of the Commission's conductivity maps in critical directions, the consulting engineer may head for the field and take actual measurements. Of course, he also runs the risk of developing information which may not be advantageous to his client's best interests.

Even in a comparatively simple hearing case, a substantial amount of engineering data must be prepared in exhibit form in order to meet the hearing issues. Theoretically, the exhibits are only documentary items to be introduced into evidence upon the oral testimony of

the expert witness, the consulting engineer. However, the integrity of the consulting engineer in his professional representation of his clients has been so well established, the communications bar has brought about the use of a procedural device permitting the submission of the testimony of the consulting engineer in written form. This procedure avoids time-consuming oral examination of the expert witness.

The agreement of counsel to employ this procedural device does not always extend to the waiving of the right to cross-examine the expert witness. Usually, the written testimony is submitted prior to hearing in order to provide an opportunity to the opposing party to review the evidence and determine whether cross-examination of the expert witness is required. The communications lawyer must rely upon the expertise of his consulting engineer in determining whether cross-examination is required. Often, genuine differences of engineering opinions arise. In order to establish a clear record for the presiding officer, who must write a decision summarizing the evidence, the expert witness must be put on the witness stand and interrogated for the purpose of clarifying and developing more fully the basis for his observations or findings in question.

Upon completion of all testimony and the introduction of the evidence required to meet the burden of proving the issues and cross-examination thereon, each adversary party has the right to introduce evidence for the purpose of rebutting the evidence which has been placed in the record by his opponent. If the record is closed without resolving differences of engineering opinion, it will be up to the hearing examiner, upon the basis of the record made, to decide which view is to prevail.

Fortunately, the communications bar has available for the hearing process a most skillful, reliable group of consulting engineers whose integrity is never challenged. In no area of the legal profession does the bar work so closely, on a day-to-day basis, as the communications bar works with consulting radio engineers in achieving the desired results for their common clients through litigation.

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Letters to the Editor

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We extended the change to our AM transmitter more than a year ago to eliminate the "hash" problem. All appeared to be rosy, our rectifier problem gone forever, but . . . we hadn't planned on lightning! This past spring was very severe in this respect. Within two months we lost half these rectifiers, and the manufacturer has refused to make them good. When you consider the cost of silicon units versus tubes, lightning can become a major factor in the use of silicon units.

I have enjoyed your magazine, and I hope that you will print this letter. Anyone in the radio business knows it is tough to get an advertiser, but when things go wrong it reflects on all. Maybe others have not had this problem; if this is so perhaps your readers will tell me what's wrong!

Very truly yours,
C. M. EDMONDS
Owner/Chief Engineer
KCMS Manitou Springs,
Colo.

Editor's Note: *This is an interesting comment on lightning and silicon. We shall be glad to print other engineers' experiences, and if any readers have a way of beating the elements BROADCAST ENGINEERING will pay regular rates for a good article on it.*

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Keeps You in View!

The Voice of America

America's Voice is described in detail and the surprising total power of the VOA operations is revealed. New plans promise megawatts of power to combat Communism.

WITHIN three months after the Japanese attack on Pearl Harbor, the Voice of America went on the air for the first time. The first broadcast, on Feb. 24, 1942, was in the German language. This broadcast heralded the beginning of a new era in the United States' foreign relations and established the pattern for the current world wide operations of the Voice of America, and its parent organization, the U. S. Information Agency.

Today, the Voice of America, speaking for the United States as the international radio service of the U. S. Information Agency, provides millions of listeners in many parts of the world with objective newscasts, up-to-the-minute facts about U. S. policies, and information concerning the life and culture of the American people. The Voice does this in 35 different languages, for a total program time of nearly a hundred hours a day.

Before Pearl Harbor, the United States was far behind other major powers in the field of international broadcasting. By early 1942, the Axis was blaring forth its propaganda to the world from approximately 75 high power broadcast transmitters. In the United States,

the international broadcasting effort consisted of about a dozen short-wave transmitters operated on a commercial basis by five privately owned broadcasting organizations. These transmitters formed the nucleus of VOA's technical network when it began broadcasting in 1942.

Since that time, and at a cost of approximately \$53 million, VOA's transmitting network has been developed into an integrated system that literally encircles the globe. Thirty shortwave transmitters, located at seven plants in the continental United States, range in power from 25 to 200 kilowatts. Overseas, VOA has nine transmitting plants with a total of 47 broadcasting transmitters ranging in power from 35 to 100 kilowatts shortwave and 50 to 1,000 kilowatts on medium and long wave.

Problems

The main technical problems that confront international broadcasting from the United States can be stated as follows:

1. The problem of overcoming the deteriorating effects on radio propagation encountered on the transmission paths from the United States passing through, or near, the northern auroral zone to the important

target areas of eastern Europe and Asia.

2. The problem of overcoming the vast distances between the United States and the target areas in order to reach listeners with competitively strong signals in the broadcast bands that are popular in the areas.

3. The problem of overcoming Communist jamming, which since 1948 has attempted to prevent reception of VOA broadcasts in the languages of the Soviet Union, its European satellites, and, more recently, China.

Development of the System

Operational experience gained during the war years clearly indicated that effective world-wide broadcasting requires a carefully developed integrated network or system of facilities, specifically designed to deliver a strong technically competitive broadcast to a listener in any selected area of the world on either the short-, medium- or long-wave broadcasting bands—whichever are popular in the specific area and can be picked-up by most of the available receivers.

Long-range forward planning is essential in the development of such a system. It cannot be devel-

By George Jacobs, Chief
Frequency Division
Office of Engineering Manager
and
Edgar T. Martin
Engineering Manager
Broadcasting Service
U. S. Information Agency
Washington 25, D. C.

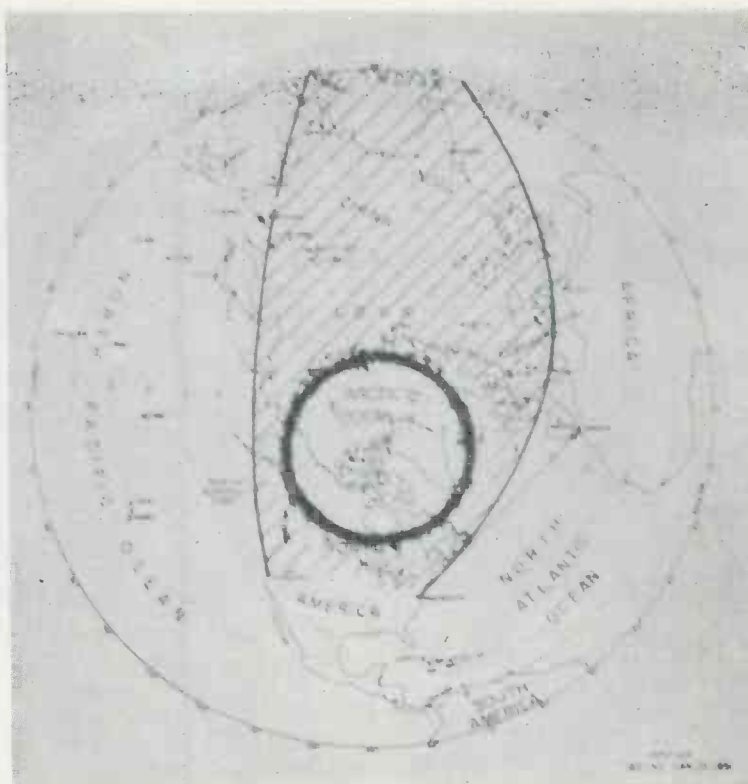
oped piecemeal, but must take into account all the interrelated elements of the system. In the case of international broadcasting, the system begins at the microphone and ends in the receiver of the listener. In the technical development of the VOA, the "systems concept"—that of considering the performance of the system as a whole—has been of paramount importance.

Relay Stations

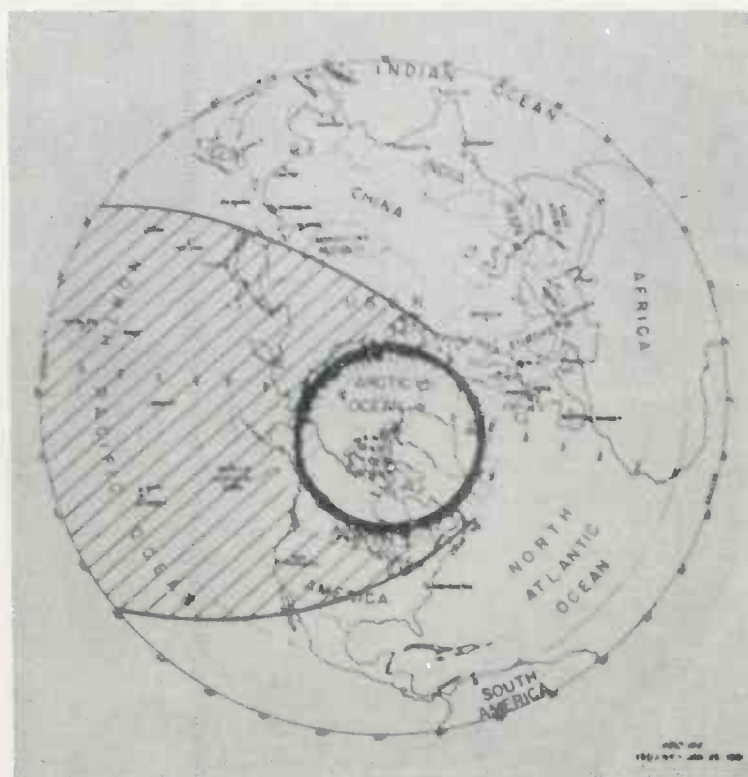
The development of the VOA facilities system centers upon the use of overseas relay stations, at locations where it is possible to take maximum advantage of favorable radio propagation conditions, to overcome the problems facing direct short-wave broadcasting from the United States.

While the transmission paths passing through the auroral zones are heavily distorted and absorbed, paths that do not pass near the auroral zones are not affected by this phenomenon. For example, the circuit from New York to Tangier, North Africa, does not pass near the auroral zones, and it is therefore possible to maintain a reliable program service from the United States to Tangier by short wave.

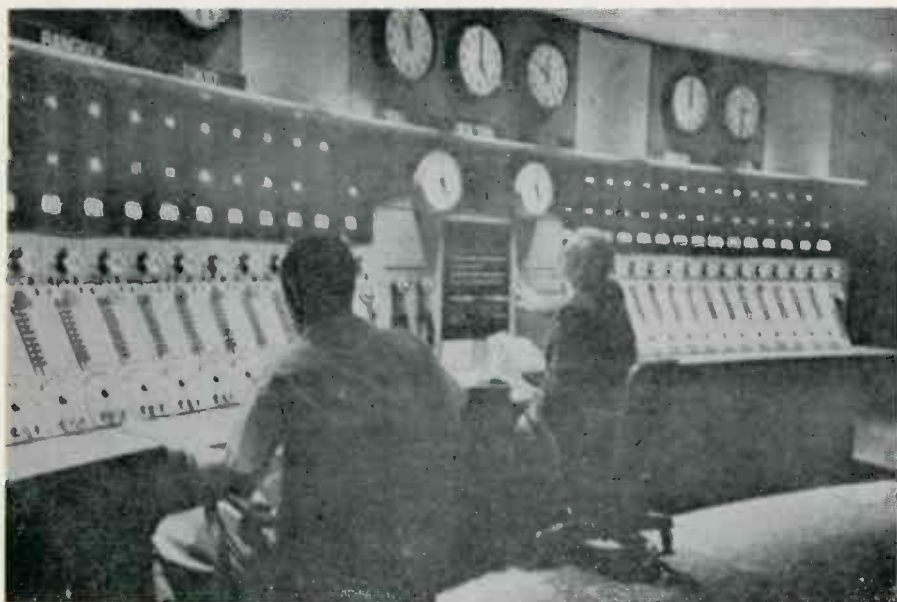
The very areas that are shielded



An arctic projection indicating the approximate location of the northern auroral zone. Cross-hatched area shows parts of the world that cannot be reached effectively from shortwave transmitters in the United States due to the shielding effect of the auroral zone. Note, however, that circuits from New York to Tangier and from San Francisco to Manila are not shielded by this zone.



The same map projection, with the cross-hatched area indicating the auroral zone shielding effect upon shortwave transmission from Tangier. Note that Asiatic and European areas shielded from direct coverage from the United States can be covered from Tangier.



The Voice of America's master control console is largest and most flexible in the world. Especially designed and built for the Voice facilities in Washington, D. C., it can select programs from 100 different sources and transmit 26 programs simultaneously. Master control is manned at all times by two radio technicians who pre-set the board in advance for each 15-minute program change. Here two technicians check the volume control while monitoring the programs.

from the United States can be reached without difficulty from Tangier. Therefore, programs transmitted from New York to Tangier can be simultaneously relayed from Tangier directly into European or Near and Middle Eastern target areas—areas that cannot be reached effectively directly from the United States. By the use of strategically located relay stations, the aural zone can be by-passed and technically effective transmissions can be delivered to target areas that are normally shielded from direct transmission from the United States.

Auroral zone by-passes to other areas of the world can be achieved by locating relay stations in, for example, Hawaii and the Philippine Islands. Both the fundamental problems of distance and auroral zone absorption can be solved by this relay station concept. Relay stations in such locations can receive short-wave transmissions directly from the United States with the least possible effects from auroral zone absorption. After receiving the transmissions, the relay station can boost them in strength and simultaneously relay them directly into selected target areas on the broadcast bands that are popular in the areas and lie within the range of most of the available receivers.

Based upon this concept, VOA relay stations have been established at various locations throughout the world. Each station is a complete self-contained installation with its own diesel power plant, small studio complement, receiving station for program reception, high-power short-, medium- and long-wave transmitting facilities, and point-to-point radio teletype communications facilities.

The relay stations are integrated into a single system so that they can be fed programs directly from the United States, or from another relay station.

The overseas relay system of the VOA consists of the following:

1. *Tangier, Morocco:* This station was designed primarily as VOA's main gateway to Europe, North Africa and the Near and Middle East. At Tangier, the major facilities consist of ten shortwave transmitters ranging in power from 35 to 100 kilowatts. Twenty-nine rhombic antennas are available for beaming programs to the various target areas.

2. *Munich, Germany:* This location is close enough to the Central European target areas so that medium- and long-wave broadcast bands can be used, as well as short-wave. The station consists of four

shortwave transmitters ranging in power from 75 to 100 kilowatts, and several lower power transmitters. A 300 kilowatt medium-wave transmitter operates on a frequency of 1,196 kc and a 1,000 kilowatt long-wave transmitter operates on a frequency of 173 kc. Twenty-six short-wave antennas are available for coverage of Europe, the Eurasian areas of the Soviet Union, Near and Middle East, and parts of Africa. The medium-wave antenna is a four-element array providing four separate patterns each beamed towards a desired European target area. This antenna system is designed for sky-wave radiation out to about 500 miles from Munich. The longwave antenna consists of a single top-loaded tower over 900 feet high. It has been designed for omnidirectional radiation to provide Central European coverage.

3. *Thessaloniki, Greece:* This relay station was engineered to take advantage of its proximity to the Balkan target areas. The station consists of four 35 kilowatt short-wave transmitters, and a 50 kilowatt medium-wave transmitter operating on a frequency of 791 kc. Twelve shortwave antennas are available for coverage of the Balkans, the western Soviet Union, east Europe, the Near and Middle East and parts of Africa. The medium-wave antenna consists of a two-element directional array providing a reversible cardioid pattern with one beam centered to provide sky-wave coverage of the Balkans and the other to provide coverage of Greece.

4. *Rhodes, Greece:* VOA's station at Rhodes is used primarily for covering adjacent areas of the eastern Mediterranean. A 150 kilowatt medium-wave transmitter beams broadcasts to this area for nine hours a day on a frequency of 1,259 kc. Two 35 kilowatt shortwave transmitters reinforce the medium-wave coverage. The Rhodes station is unique in that the transmitting facilities are housed aboard a vessel, the U. S. Coast Guard's Courier. The Courier does not, however, broadcast from the high seas. The vessel operates as a fixed installa-

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tion, either from an anchorage in Rhodes harbor, or from within the national waters of Greece, with the approval of the Greek government.

5. *Philippine Islands*: VOA maintains transmitting facilities near Manila and San Fernando on the island of Luzon. These facilities consist of six shortwave transmitters ranging in power from 35 to 100 kilowatts, a 50 kilowatt medium-wave transmitter operating on 920 kc, and a 1,000 kilowatt medium-wave transmitter operating on 1140 kc. Twenty rhombic antennas are available for beaming shortwave broadcasts over an arc extending from Korea to India. The 50 kilowatt medium-wave transmitter uses a six-tower array for sky-wave coverage of the Philippines and adjacent areas of Southeast Asia, while the megawatt transmitter uses a four-tower array which produces three separate beams directed towards Southeast Asia, and parts of China. This antenna system increases the effective power of sky-wave radiation to 3,500 kilowatts in certain directions.

6. *Okinawa*: VOA's Okinawa installation completes Far Eastern coverage by beaming short and medium-wave broadcasts to northern and central Asiatic areas. This station consists of three shortwave transmitters ranging in power from 35 to 100 kilowatts, and a 1,000 kilowatt medium-wave transmitter operating on 1180 kc. Six rhombic antennas direct shortwave transmission to Siberia, the Far East, China and Central Asia. The medium-wave antenna consists of a six-element array producing two beams directed towards China, Manchuria, Korea, and the Soviet Far East.

7. *Colombo, Ceylon*: This installation, operated for VOA by Radio Ceylon in accordance with an agreement between the governments of the U. S. and Ceylon, is intended primarily for coverage of India and Pakistan. The station consists of three 35 kilowatt shortwave transmitters. A large number of curtain arrays are available for beaming broadcasts to India, Pakistan and adjacent areas.

8. *Woofferton, England*: Six 50 kilowatt shortwave transmitters, operated for VOA by the British

Broadcasting Corp., on a contractual basis, beam Voice broadcasts to Europe, Africa and the Near and Middle East. Twenty-six high-gain curtain antennas are available for directing these transmissions to their target areas.

9. *Honolulu, Hawaii*: This station, located in the nation's newest state, serves as an auroral by-pass to the Far East and Southeast Asia. It consists of two 100 kilowatt shortwave transmitters and seven rhombic transmitting antennas.

"Feeder" Link

The 47 overseas stations of the VOA have just been described. They are the links in the over-all system effort directed towards the selected target areas. The link from the United States to the overseas stations is referred to as the "feeder" link in the over-all system. It consists of 30 high-power shortwave transmitters located at seven plants in the continental United States. These high-power transmitters employ high-gain directive transmitting antennas for the dual purposes of feeding program transmissions from the studios of the VOA to the overseas relay stations for simultaneous relay into selected target areas, and also providing supplemental direct target area coverage during periods of favorable propaga-

tion conditions. The following facilities are used for this purpose:

1. *Bound Brook, N. J.*: Six 50 kilowatt shortwave transmitters and 17 high-gain antennas beamed towards Europe, North Africa and South America.

2. *Brentwood, N. Y.*: Three 50 kilowatt shortwave transmitters and 19 high-gain antennas beamed towards Europe and South America.

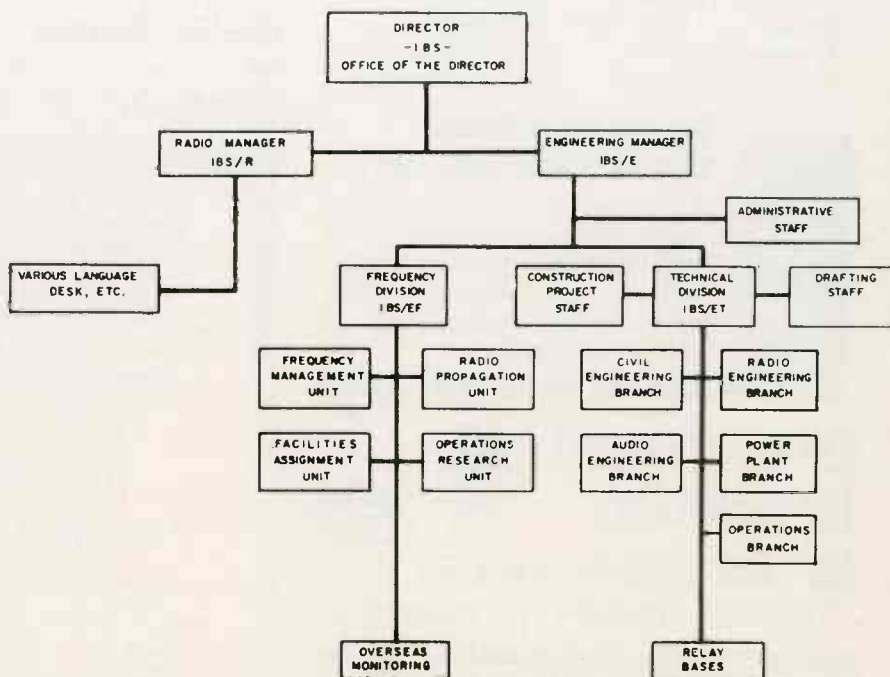
3. *Schenectady, N. Y.*: Three shortwave transmitters ranging in power from 25 to 100 kilowatts and eight high-gain antennas beamed towards Europe and South America.

4. *Wayne, N. J.*: Two 50 kilowatt shortwave transmitters and four high-gain antennas beamed towards Europe.

5. *Bethany, Ohio*: Six shortwave transmitters capable of operation at powers between 50 and 140 kilowatts and 22 high-gain antennas beamed towards Europe, Africa, and South America.

6. *Delano, Calif.*: Five shortwave transmitters ranging in power from 50 to 200 kilowatts and 22 high-gain antennas beamed towards Southeast Asia, the Far East, Siberia, and South America.

7. *Dixon, Calif.*: Five shortwave transmitters ranging in power from 50 to 200 kilowatts and 20 high-gain antennas beamed towards Ha-



Headquarters for VOA's engineering staff is in Washington, D. C. The chart illustrates the many functions performed by the 100-man engineering staff.



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The Model 58 is 4" long, weighs only 3½ ounces. Complete with lavalier; or it can be adapted to a desk or floor stand. Level (RETMA) —149 db. Response 60—13,000 cps. Allows a choice of either hi impedance or 150 ohms selected at the free end of the cable. Model 58A: combination 50 or 200 ohms selected the same way. Net price \$34.20. For complete specifications, write:



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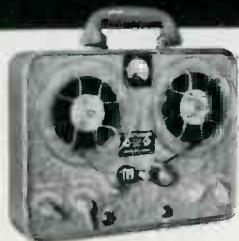
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Professional Transistorized Portable Field Recorders

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TransFlyweight® Series 312: 8 lbs.; electric motor,
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Operates 125 hours from rechargeable batteries.

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vail, Australia, Southeast Asia, the
Far East, and South America.

Washington Headquarters

For the most part, VOA programs
originate from its Washington, D.
C., headquarters plant. The Wash-
ington facilities, which take up
nearly 100,000 square feet in the
Health, Education and Welfare
Building on Independence Avenue,
include eighteen studios, equipment
to make forty different disc or tape
recordings simultaneously, ten tape-
editing booths, a recording control
center, the Master Control, engi-
neering offices, editorial offices,
music and transcription libraries,
and various other service units
which are required to keep VOA in
operation 24 hours a day.

VOA's Master Control is one of
the largest and most flexible in the
world. It feeds programs originating
in VOA studios, through special
telephone circuits, to the shortwave
transmitters in the United States.
The Control Console is capable of
selecting program material from 100
sources and of handling 26 programs
simultaneously.

This completes the systems con-
cept of the VOA world-wide inter-
national broadcasting network. VOA
broadcasts originating in studios lo-
cated in Washington, D. C., are fed
through appropriate control equip-
ment and land-line circuits to any
one of 30 feeder transmitters located
at seven plants in the United States.
These programs are then broadcast
over the high-power shortwave
"feeder" transmitters, employing
high-gain directional-antenna sys-
tems, to any one of forty-seven high-
power transmitters located at nine
overseas relay points throughout the
world. The circuits to the relay sta-
tions by-pass the auroral zone of
exceptionally heavy r-f absorption.
The relay stations, located at opti-
mum distances from the selected
target areas, boost the level of the
signals received from the "feeder"
transmitters and simultaneously re-
lay the broadcasts directly into the
target areas on either the short,
medium-, or long-wave broadcasting
bands, whichever are popular for

broadcasting in the target areas.
Often during periods of favorable
propagation conditions, secondary
target-area coverage is also obtained
directly from the transmitters lo-
cated in the continental U. S. A.

Jamming

Communist jamming of VOA
Russian-language broadcasts was
first observed in February, 1948.
Since that time, jamming has con-
tinued and it is believed that ap-
proximately 2,000 radio transmit-
ters are presently being used to jam
Russian, European-satellite and Chi-
nese-language transmissions of the
VOA and other broadcasters.

Jamming consists mainly of irri-
tating noises which sound like buzz
saws, sirens, white noise, etc., placed
on the same frequency as the VOA
transmissions for the purpose of
making reception of the program
difficult, if not impossible. Although
intentional interference of radio
transmissions violates international
radio agreements, these transgres-
sions continue.

Concurrent with the development
of the system itself, certain tech-
niques have been devised in the
form of electronic devices such as
heterodyne filters, speech clippers,
exalted carrier type receivers, etc.,
the use of high-power transmitters
and high-gain antennas, the advan-
tageous use of favorable propaga-
tion conditions when these exist, the
transmitting of the same program
simultaneously from various relay
stations located at different geo-
graphical locations, broadcasting on
an around-the-clock basis, increas-
ing the number of broadcasts in the
English language, which are not
jammed, as well as continuous study
of the problem.

That many broadcasts can be
heard in spite of jamming is clear
from reports of monitoring stations
located on the rim of Communist
territory, from systematic question-
ing of visitors to and escapees from
the Soviet orbit, from letters writ-
ten by Soviet bloc listeners, and
from violent attacks on the Voice
by Communist dignitaries and by
the press and radio of the Soviet
Union. Nevertheless, jamming is ef-
fective and represents a major prob-
lem for the Voice of America.

Now Facilities

The growth and competition in
the field of shortwave broadcasting

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RACKS?**

Turn to section 1400



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continues at a dynamic pace. Short-wave broadcasting throughout the world increased 13% during 1960, with about 140 countries engaging in this medium of mass communication. VOA's greatest competition, from the standpoint of the number of hours devoted each day to short-wave programming, comes from Radio Moscow, Radio Peking and the UAR's "Voice of the Arabs;" each of these devotes more time than the VOA to shortwave programming.

The increased availability of transistorized radio receivers at steadily lowering costs has also played an important part in the recent upsurge in the popularity of shortwave broadcasting. With receivers independent of power lines and capable of being operated for months on a few cheap batteries, radio can now penetrate into rural and underdeveloped areas, opening up vast new potential audiences, both for the Voice of America and its competitors.

Congress has recently appropriated funds for two major steps in this program. The first of these is a new domestic plant now under construction in Greenville, N. C. This plant will provide VOA relay stations in Europe and the Mediterranean area, more reliable and higher quality signals, and will also improve the capability for direct broadcasting to some areas of Europe, Africa and Latin America. The principal transmitters will number six 500 kilowatt shortwave, six 250 kilowatt shortwave, and six 50 kilowatt shortwave. This new installation, being built at a cost of nearly \$24 million, will be the world's most powerful shortwave broadcasting station when it comes on the air during early 1963. It will permit VOA to discontinue use of 14 obsolete shortwave transmitters at other domestic plants, some of which have been in service for more than 25 years.

The other new technical facility approved by Congress is a relay station in Africa, now under construction near Monrovia, Liberia. This station, being built at a cost of approximately \$13 million, will provide VOA, for the first time, with competitive shortwave coverage of the entire African continent. The six 250 kilowatt and two 50 kilowatt short-

wave transmitters planned for the Liberian installation are expected to go into operation during mid-1963. The new station will partially fill the coverage gap that will result when VOA's Tangier station ceases operation on Dec. 31, 1963, the termination date of the present agreement with the Moroccan government. It will also improve VOA's coverage capability in parts of the Middle East and Europe during critical periods of low sunspot activity.

The Office of the Engineering Manager, VOA's engineering headquarters in Washington, is made up of approximately 100 engineers, communication specialists, technicians and supporting clerical personnel. Of this number, about one-third hold degrees in the various fields of engineering or associated sciences, or are registered Professional Engineers. Overseas, VOA employs approximately 625 communication specialists and technicians, 86 of whom are American.

Concertone

Proudly Presents the New SERIES 90

Concertone's new Series 90 represents the first breakthrough in the commercial/professional recording equipment field at a medium price. Designed for rugged reliability under continuous performance conditions, the Series 90 meets the most exacting broadcast requirements.

Note These Outstanding Features

EDIT-O-MATIC — provides the countless advantages of high speed search, cueing and editing.

AUTOMATIC TAPE LIFTERS — eliminate the annoyance of "squeal" in fast mode.

FOUR HEADS — allow reproduction of monaural, 2-track or qtr. track tapes with the flick of a switch. The fourth head position can also be used for special heads.

ELECTRIC RELAYS — provide instant, positive action for stop, start, fast forward and rewind modes.

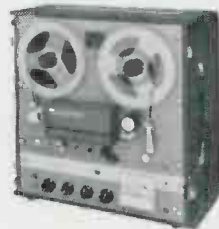
REMOTE CONTROL — record, stop, start, fast forward and rewind.

NEW TAPE TRANSPORT — precision design and construction. 3 motor drive system, including the heavy duty hysteresis synchronous capstan motor.

These exciting features mark the Series 90 as the ultimate in professional recorders. From \$925.00.

THE NEW 508—AT A MODEST PRICE

Advanced recorder design with professional reliability, extreme fidelity and tape-handling ease. The 508 has no equal for broadcast performance or custom installation. Available as a precision tape player or with separate electronics for mono or stereo recording. In half or full track at \$520.



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Industry News

Stephens Appointed to Vitro Electronics Post

Vitro Corp. of America, 261 Madison Ave., New York 16, N. Y., has announced the appointment of Robert R. Stephens as chief electronics engineer for Vitro Electronics Div.

G. C. Schutz, vice-president for sales and engineering, said Stephens will be responsible for all electronic engineering and design activity in a stepped-up development program. Stephens is recognized for his work in design and development of telemetry receivers, transmitters and countermeasure equipment. He has 15 years of electronics experience, ranging from radar and microwave equipment to telemetry.

Construction Contract To Collins Radio Co.

The U. S. Information Agency has announced the awarding of a

contract to Collins Radio Co., Dallas, Tex., for the construction of a highly-mobile radio relay station, equal in power to four top U. S. broadcasting stations. The self-sufficient broadcasting facility will be air transportable and can be made operational within 30 days after unloading. It will augment the flexibility of the Voice of America's 87 present transmitters at 17 locations throughout the world. The builder will be Alpha Corp., 820 E. Arapaho Rd., Richardson, Tex., a division of Collins.

The facility, complete with long-range receivers, studios, workshops, microwave communications systems, generators, fuel tanks, transmitters and sectionalized antennas, will be built to fit into truck-trailer-type units. Weight and size of segments will permit movement by cargo planes, railroad, ships or

tractor trucks. It will operate in temperatures ranging from 20 deg. below zero Fahrenheit to 120 degrees Fahrenheit, and will be operated by a crew of 18. Four 50,000-watt transmitters will be included, three of them short wave, the fourth medium wave.

The units will augment existing U.S.I.A. fixed radio relay broadcasting stations on a temporary or emergency basis, will provide temporary service in those areas where fixed radio relay stations are being built, and will supply emergency service, when necessary, in remote areas where no adequate VOA broadcasting service is available.

Portland Station Installs Gates Broadcaster Transmitter

The purchase of a Gates model BC-50C, 50,000-watt, AM broadcast transmitter by radio station KGON, Portland, Ore., has been reported by Gates Radio Co., Quincy, Ill., a subsidiary of Harris-Intertype Corp. The contract also included phasing equipment and totaled nearly \$150,000.

According to KGON's general manager, Irwin S. Adams, the station has progressed steadily since it went on the air on July 4, 1947, with a power of 250 watts. In July of 1956, KGON changed frequency from 1230 to 1520, boosting power at that time to 10,000 watts with a Gates 10-kilowatt AM transmitter. The power jump to 50 kilowatts with the new Gates equipment will result in a site move but no change in frequency.

Larry Cervone, Gates' vice-president of sales, reports that the KGON order marks the eighteenth Gates 50-kilowatt broadcast transmitter — both medium and short wave models—purchased since the development of such equipment by Gates early in 1957. Of the 18, eight were purchased by the United States Information Agency, five by customers overseas, one in Mexico, two in Canada, and two by U. S. broadcasters.



Presentation of the Scott Helt Award of Professional Group on Broadcasting is made by Raymond Guy, chairman, to James H. Greenwood at the annual fall meeting in Washington, Oct. 6-7.

**Canadian Sales Company
Formed by Hewlett-Packard**

Hewlett-Packard Co., Palo Alto, Calif., has announced the formation of a Canadian sales company to handle the firm's products in Canada.

The new company, Hewlett-Packard (Canada) Ltd., will have its principal office, warehouse and service facility in Montreal, with branch offices in Ottawa and Toronto. It was to begin operations Jan. 1, according to W. Noel Eldred, vice-president of marketing, who also pointed out that the company has been marketing its products throughout Canada for many years.

Ralph Haywood has been appointed manager of the newly formed company. He was formerly eastern regional manager of ROR Associates, a Canadian electronic sales representative firm, and is an electrical engineering graduate of the University of Manitoba in Winnipeg. According to Haywood, the new company will be fully staffed with Canadian sales engineering and service personnel who have been undergoing comprehensive training at Hewlett-Packard in Palo Alto for the past year.

**Universal Recorders and
Radio Recorders Merge**

A merger of Universal Recorders and Radio Recorders, both pioneer companies in the field of film and sound service, was announced recently by Martin Hersh, Universal president, in a deal which reached near the million dollar mark, and was completed when Hersh acquired all of the stock of G. Howard Hutchins and H. DeVoe Rea, owners of Radio Recorders.

Harry L. Bryant and Ernest F. Dummel, of Radio Recorders Co., will continue as officers and directors of the newly merged firm. Plans are under way for the installation of new equipment and for further expansion of the company, which henceforth will operate under the name of Radio-Universal Recorders, Hersh said.

The firm's present clientele includes motion picture studios and producers, advertising agencies and national advertisers, and it is said to be an accepted contractor for top secret government film and recording work.

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GUARANTEED! FOR ONE YEAR!

Check this equipment against any other for compactness, efficiency, reliability, design and low maintenance requirements—and you will see why the SPOTMASTER Cartridge Tape Recorder is the recognized standard of the industry. And why not! It is the most field tested and field proven cartridge equipment manufactured anywhere. Just insert a cartridge, push a button and your spot is on the air, instantly—on cue, on time, every time with no fluffs—only the highest quality sound for every client. New heavy duty deck with hysteresis synchronous motor, at no increase in cost. SPOTMASTER is available in the BE500 combination recorder-playback model and BE505 companion playback model. For further information wire or write today.

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Industry News

Radio Shack Plans New Electronic Supermarket

Radio Shack Corp., Boston, Mass., has announced that groundbreaking ceremonies were held recently for the new electronic supermarket and industrial distribution center in New Haven, Conn. The present store, located on Crown St., will relocate in the new University Towers Shoppers Parcade some time after the first of the year.

The new Radio Shack will feature all of the departments found in other units operated by the Boston-based electronics distributor. There will be a sound room with an audio comparator, amateur radio equipment, records and tapes, tape recorders, and optical equipment. Industrial accounts will find an extensive display of test equipment, technical publications, and hundreds of industrial electronic components.

The new unit will be managed by Edward Alberino, who has managed the New Haven store since 1959.

UPCOMING PROFESSIONAL MEETINGS

Feb. 2: Deadline for comments on FCC proposal to extend use of UHF-TV bands.

Feb. 7-9: National Winter Military Electronics Convention, Los Angeles.

March 20: Annual National IRE Convention.

April 1-4: National Assn. of Broadcasters National Convention, Chicago.

April 29-May 4: SMPTE Semi-Annual Convention, Los Angeles.

Miratel Electronics Diversifies Operation

Miratel Electronics, Inc., Richardson St., New Brighton 12, Minn., has purchased the assets and business of Schroeder Specialty Painting Co., Minneapolis, and Oscar Schroeder, former owner of the paint company, will continue with Miratel to manage the new acquisition.

Thus Miratel not only diversifies its operation into another field of endeavor, but also protects one of its important lines of supply, according to William S. Sadler, Miratel executive vice-president.

Equipment and facilities of the Schroeder operation will be moved to Miratel's main plant at New Brighton, and all previous Schroeder customers will continue to be served as in the past, Sadler stated. It was also announced that the main plant will be expanded to twice its original size.

Hewlett-Packard Forms Two New Divisions

Two new divisions were formed recently by Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. The advanced research and development division will investigate new product areas and provide development services for other operating divisions. The frequency and time division will engineer and manufacture precision frequency counters and time measuring devices.

Dr. Paul E. Stoff, who has been with Hewlett-Packard since 1958, has been named manager of the advanced R & D division, and Alan S. Bagley will become general manager for the new engineering and

production division. Bagley has been with the company since 1949, and was previously engineering manager for the firm's frequency counter division.

Air Force Color TV Contract Expanded

The headquarters USAF Pentagon color television system contract, providing for the use of TV as a management tool, has been expanded to \$507,000.

This closed-circuit color TV system has been engineered and produced especially for the Air Force by Foto-Video Electronics, Inc., and currently is 60 per cent installed on the 5th floor of USAF headquarters, Pentagon. This is the largest known color TV system in the world engineered especially to serve as a management aid for the presentation of current information and data to decision-making headquarters staff level. The original contract was for \$448,000.

Other uses are to provide a more efficient system for briefing and communication with the USAF staff, to save vital time for key air staff officials, and to make it possible to create a library of current and past briefings.

Facilities for the 30,000 square foot headquarters Air Force TV Center include a master studio, control equipment, maintenance shop area, five Weapons Board panel rooms, and seven viewing-conference rooms—varying in capacity from twenty to 135 persons.

Inputs to the color TV Center provide for the inclusion of briefings and data from all Air Staff Agencies, including live briefings

Spot-O-Matic

Revolving cartridge rack



THE SOLUTION FOR CARTRIDGE STORAGE PROBLEMS. HOLDS 80 STANDARD FIDELIPAC CARTRIDGES WITH A BASE AREA LESS THAN 1 SQUARE FOOT. STANDS ONLY 30 INCHES HIGH. FINISHED IN GREY FORMICA.

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600' Acetate (plastic), 5"	.75
600' MYLAR 5" reel.....	.95
900' MYLAR (Polyester), 5"	.99
1200' MYLAR, 1/2 mil. 5" reel.....	1.18
1200' Acetate (plastic), 7"	1.19
1200' MYLAR, 1/2 mil. (Strong).....	1.68
1800' Acetate (plastic), 7"	1.79
1800' MYLAR, 1 mil. thick, 7"	1.99
2400' MYLAR, untensitized, 7"	2.69
2400' MYLAR, tensitized, 7"	2.99

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NORELCO SPEAKER
Famous AD3800M, twin cone 8" (75-19,000 cycles) discontinued model, former list 16.00, usual net 9.90 going at 3.73 plus postage, (8 for 27.85). Other Norelco speaker sizes at bargain prices. Send for **SPEAKER SPECIFICATION SHEET.**

and tapes forwarded to the Pentagon by major air commands; scheduled daily programs, including news and weather and Congressional developments; scheduled training programs, and the programs, if and when desirable, of the nation's commercial radio and TV programs.

As to security, the entire Pentagon Color TV area containing the closed-circuit facility and its distribution network, will be a secure area. All connecting cables to the Auditorium will be patrolled during transmission of classified programs.

There are five programming capa-

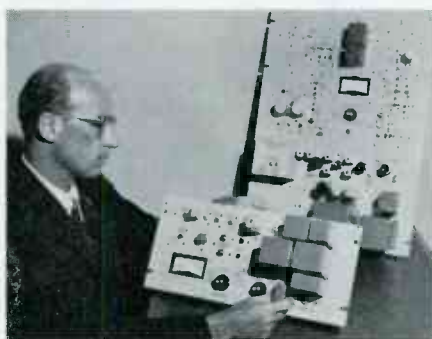
bilities: 1—for live program sources; 2—video tape room; 3—film chain (for presentation of both films and slides); 4—live pickups from the War Board panel rooms; and 5—a bank of TV and radio tuners to introduce commercial network program. Such programs may be forwarded by cable to a large conference viewing room for projection on a large wall screen, and to a dozen or more of smaller rooms for viewing by limited groups in black and white or color on special 27-inch monitors manufactured by Foto-Video.

WVCG Sells Total Time With FM Stereo Equipment

The complete sell-out of FM stereo program time within the first week of using the latest concept in FM stereo multiplexing developed by Collins Radio Co., Dallas, Tex., was jointly cited by George W. Thorpe, president, WVCG, Coral Gables, Fla., and A. Prose Walker of Collins.

According to Walker, a new feature of the equipment is that it has overcome the inherent instability of the double injection method of FM stereo broadcasting because in the newly developed stereo multiplexer both channels of the stereo signal are fed into the exciter as a composite signal. "This not only results in an FM signal significantly more stable than any other method can produce," Walker explained, "but it also produces a better monaural signal for those listening on a monaural receiver."

The FM stereo multiplex signal is fed into Collins' recently developed 830A-2, 10-watt exciter, which is designed to accept not only FM stereo, but monophonic and SCA audio inputs from 30 cycles to 75 kc

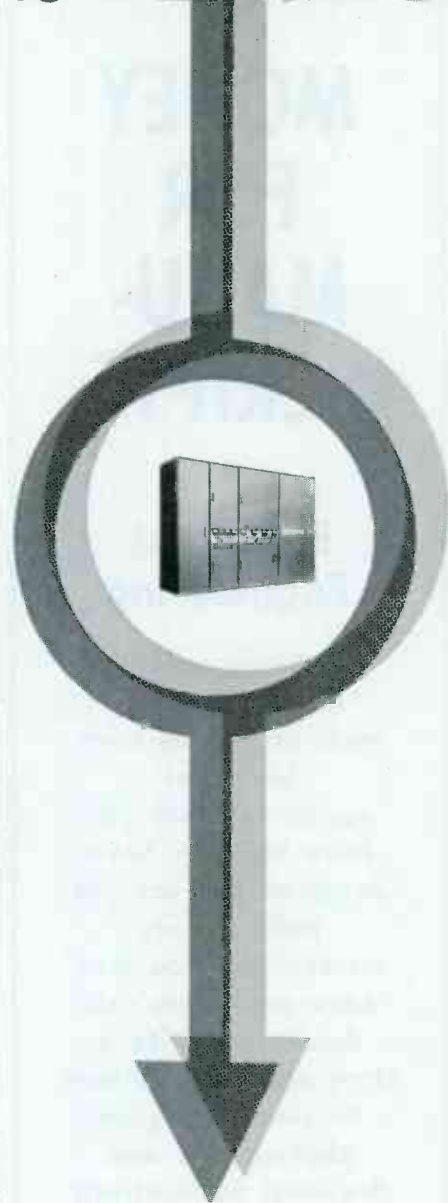


The Collins FM stereo multiplex is displayed in the foreground by A. Prose Walker, who was responsible for its design and development.

directly, which means no auxiliary modulators are used for stereo signals or SCA signals. All transistorized, except for five vacuum tube stages in which transistors are not applicable, the 830A-2 exciter is said to eliminate the undesirable multiplication of oscillator drift in broadcasting because, instead of multiplying oscillator frequency, the full FM signal swing is developed at 14 mc and heterodyned to output frequency.

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They Get Results!**

STEREO



NOW YOU CAN PRODUCE EXTRA STEREO DOLLARS WITH NEW HIGH POWER 15 AND 30 KW FM STEREO TRANSMITTERS FROM GEL WITH SAME RELIABILITY AND QUALITY BUILT-INTO ALL GEL FIELD-PROVEN EQUIPMENT.

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actively solicits readers' written material. If you have ideas for equipment that you have built, or have designed but not yet built, or any installations you may have made, etc., sit down and write a story about it. Be sure to send plenty of photographs and drawings to illustrate it. We can use from one magazine page to three, or even four if the story is of sufficient interest. Our regular rates will be paid promptly on acceptance by the editor.

\$

Book Reviews

Electronics Math Simplified

By Alan Andrews. Published by Howard W. Sams & Co., Inc., The Bobbs-Merrill Co., Inc., Indianapolis and New York. Price: \$4.95.

The preface says that this book is for the engineer, technician or student who requires a knowledge of math as it specifically relates to electronics. This is the first edition, and it seems likely that it could run into several more, with variations; and perhaps an advanced version. The book is if anything too simple, and belies its title at least as far as the first few chapters are concerned. On the other hand, as the text progresses further into more difficult material one gathers the impression that more time could have been spent defining certain expressions and operations.

The chapter on antennas and field strength, although very simple and brief, will help provide light to many a station engineer who has trouble deciding why his signal strength is not what the manager thinks it should be! There is even a section on binary numbers and theory, but not enough to make the reader into a computer specialist. All the usual mathematical problems are found in the 20 chapters. The chapter on power factor contains the most lucid explanation that this reviewer has ever seen, and no one should fail to understand what it is, and does, after reading chapter 13. However, it might have been a good idea to explain what "high" and "low" power factors mean, and why "poor" factors are undesirable.

Recommended for the radio station's technical library.

Handbook of Electronic Charts and Nomographs

By Allan Lytel. Published by Howard W. Sams and Co., Inc., The Bobbs-Merrill Co., Inc., Indianapolis and New York. Price: \$4.95.

If you are a lazy engineer (and who isn't?) you will find this selection of 58 charts and nomographs indispensable. Compiled by a past

master in the writing field of electronics and math, these form a very valuable addition to the reference library.

The author has taken a practical view of using nomographs, and provided a sanded plastic sheet which is bound into the book, and on which the necessary lines joining the various scales can be drawn. This removes the general messy appearance of partially erased lines that develops on an ordinary paper page after constant use.

Particularly careful precautions have been taken to ensure that the charts are accurate by preparing the originals much larger than the reproductions, and reducing to the required size. At the same time distortions in reproduction have been eliminated.

There is not room to list all the nomographs included; however, they range from the simple area of a circle, and Ohms Law, to UHF Skin Effect, modulation percentage, and a selection of impedance and reactance curves.

Tube Substitution Handbook Volume 3

Howard W. Sams & Co., Inc., Indianapolis 6, Ind. Price: \$1.50.

This is the third edition of Volume 3, second printing, of that perennial best seller and every technician's friend—the Tube Substitution Handbook. With the ever increasing flow of foreign radio and television equipment into radio and TV stations the need to know what US tubes will replace many foreign types grows greater daily. This book gives all the answers.

The book is divided into five sections: One—Cross Reference of US Types; Two—Industrial Substitutes for Receiving Tubes; Three—European Substitutes for Receiving Tubes; Four—American Substitutes for European Types and Five—Picture Tube Substitutes.

The breakdown makes it a simple matter to determine what, if any, foreign type tubes can be replaced by US, or *vice versa*; and what to use if you have only a limited supply and must replace one US type by another. There is not much more one can say about this type of book—it is as basic to a radio man, as a rifle is to an infantryman.

Product News



NEW JERROLD AUDIO-TROL

A modulator designed to replace an entire audio distribution system for hotels, motels or institutional use, has been developed by Jerrold Electronics Corp., 15th and Lehigh Ave., Philadelphia 32, Pa. The Audio-Trol (model AT) provides for adding AM, FM, background music or public announcements to any TV distribution system, and is said to eliminate the need for additional audio system equipment and installation by utilizing the unused television channels of a standard TV receiver for audio reception.

The source feeding the equipment may be an FM tuner, an AM radio, Muzak, records, tape or microphone. Audio programming is piped from the head-end of the TV distribution system, where the Audio-Trol is installed, to any room in which there is a TV receiver. The manufacturer states that the new unit can feed five separate channels of audio, even in seven channel TV areas, since the circuitry of the equipment has been engineered to prevent cross-modulation between adjacent channels. The channel conversion is achieved by providing a crystal-controlled video carrier and an FM sound carrier. The latter, held precisely at 4.5 mc separation from the video carrier, produces the audio program through the TV speaker. The Audio-Trol has been designed for rack mounting, and power requirements are 45 watts at 117 volts, 60 cycles ac.

MICROWAVE CATALOG

A 32-page catalog of microwave instrumentation has been released by Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Because of the unique requirements of the microwave engineer, the company has, for the first time, developed a special catalog dealing only with the generation, transmission and measurement of microwave phenomena. The contents have been conveniently arranged by frequency range rather than by model number.

Designed to be educational, as well as convenient to use, the first few pages briefly review the basic microwave measurements, and photographs of typical equipment set-ups for these measurements appear throughout the catalog.

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DIALS?**

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due to technical difficulties beyond....!



You probably have an educated appreciation for the situations, problems and costs that rear up in connection with electronic communications equipment failures — especially when the equipment is relied upon for national security, network programs, law enforcement and industrial services.

Electron tube failures, caused by heat, are the main reason for 70% of electronic equipment failures and a common cause of communications and telecasting program interruptions — easily corrected with IERC TR type heat-dissipating electron tube shields. Even new tubes can be improved to better-than-new life and reliability 2 to 12 times with TR's.

Effective bulb temperature reductions obtained with TR's plus maximum retention, shock and vibration protection combine to prevent tube failures — and eliminate costly tube replacement and down-time delays as well as lonely moonlight 'maintenance' hikes!

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heat-dissipating tube shields for miniature, subminiature, octal and power electron tubes

Product News



AUDIO/VIDEO TRANSMITTER

Marsan Industries, Inc., American Telecircuits Div., 49 Edison Place, Newark, N. J., has introduced a new transmitter designed to feed audio and/or video programming into any closed-circuit TV or master TV system, and which employs a simplified modulator circuit that is said to simulate a TV broadcast studio.

The model TT-1 transmitter feeds audio and/or video into a closed circuit system on an unused VHF channel. Composite output capacity is 0.1 volts. Three audio inputs accept signals from microphone, tape recorder or audio line. Receptacles are RCA-type audio jacks, and video output is a co-axial receptacle of the SO-239 type.

Applications of the unit include educational TV programming; institutional needs such as special programs for hospitals, etc.; local announcements and commercials in hotels; addition of background music to master TV and community TV systems; security interviewer systems for apartment houses, factories, etc.

The A-V transmitter is compact in size, weighs approximately 6 lb., and employs four tubes. Circuit features include transformer isolation and dc restoration.

NEW KROHN-HITE CATALOG

Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge 39, Mass., has made available a new six-page short form catalog describing the latest additions to the company's line of precision electronic instruments.

Included in the illustrated, two-color cata-

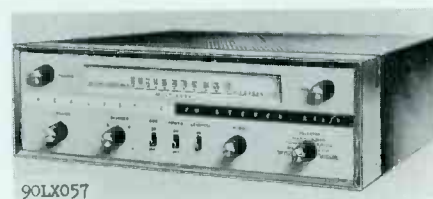
log are condensed technical specifications and prices of the new transistorized and tube-regulated power supplies, ac power sources, wide-range RC oscillators, variable electronic filters, and laboratory power amplifiers.



STEREO CARTRIDGE TAPE EQUIPMENT

Sierra Electronic Enterprises, 6430 Freeport Blvd., Sacramento, Calif., has announced a newly developed stereo cartridge tape playback and record unit, which is made up of the company's cartridge transport and amplifier units.

The stereo equipment utilizes the cue-stripe method of cue control, to allow the stereo heads to be free of any tone cue signal. The SE-10 Stereo contains all of the Spot-o-Matic features and is said to provide complete playback and recording of stereo cartridge tapes.



STEREO FM MULTIPLEX TUNER AND AMPLIFIER

Radio Shack Corp., 730 Commonwealth Ave., Boston 17, Mass., has announced the Realistic model STA-7 stereo FM multiplex tuner and amplifier, designed to make possible direct reception of stereo multiplex transmissions currently being initiated from FM stations throughout the country.

The STA-7 is said to provide driftfree FM or stereo FM multiplex reception with a flip of a switch, and incorporates a 24-watt stereo amplifier (12 watts each channel, with 48 watt peaks). The tuner section has 14 tubes (11 dual purpose for 25 tube performance) and provides a sensitivity of 2.5 uv for 30 db of quieting.

Additional features include on/off AFC; grounded grid RF stage; ratio detector; third channel output; and full range of controls. The amplifier section has a frequency response of 20 to 20,000 cps $\pm$ 1 db. In addition, it may be used as a stereo or mono amplifier for any phone or tape deck by utilizing the input jacks built in for this purpose. The unit also has output terminals for 4, 8 and 16-ohm speakers, plus output jack for stereo headphones.

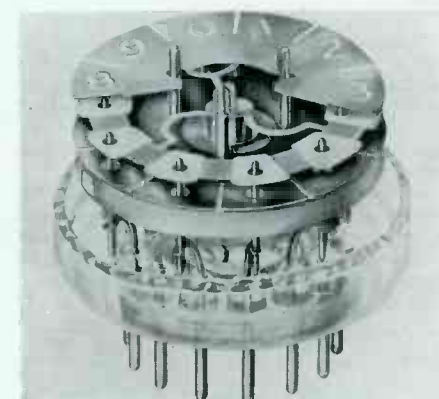


ELECTRONIC REVERBERATION UNIT

A new electronic reverberation unit, the Knight KN-702, is being offered by Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. By electronically simulating sound-reflecting panels used in recording studios, the KN-702 is said to give broadcasts and acoustically dead records the same live reverberation that provided depth to performances in auditoriums, concert halls and cathedrals.

The new unit features a device called the Hammond Type 4 reverberation chamber, designed to delay the audio signal for a fraction of a second, just long enough to produce the reverb effect. The other element is a 4-tube amplifier with a volume control which is said to enable the listener to adjust the reverberation to suit his personal listening tastes and room acoustics.

The output of the reverberation amplifier is connected to standard speakers used with hi-fi systems (8 or 16 ohms). The KN-702 can be connected to the speaker output terminals of any existing hi-fi amplifier, and no circuit changes are necessary. Complete instructions are included.



INDICATOR TUBE DESIGNED FOR USE WITH TRANSISTORS

Amperex Electronic Corp., Semiconductor and Special Purpose Tube Div., 230 Duffy Ave., Hicksville, Long Island, N. Y., has

NEW!

HIGHER GAIN SERIES FM ANTENNAS DESIGNED FOR MULTIPLEX STEREO

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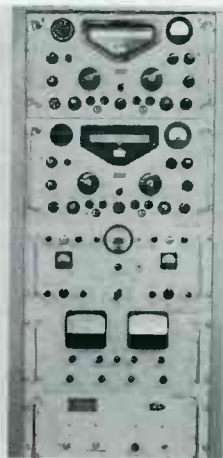
36

for Details

developed an indicator tube designed to operate directly off transistors.

Designated type Z550M, the unit is a cold cathode, gas-filled tube, which is said to require less than five volts at less than 50 uA to produce a discharge. The indication is a bright red neon glow which is viewed through the dome of the tube envelope. Special characteristics are designed to make it possible for the Z550M to operate directly off commonly used low voltage transistors, without any intervening circuitry or costly high voltage transistors. The unit, offering over 30,000 hours of operation, is recommended for use with solid state counters, computers, digital voltmeters and scalars.

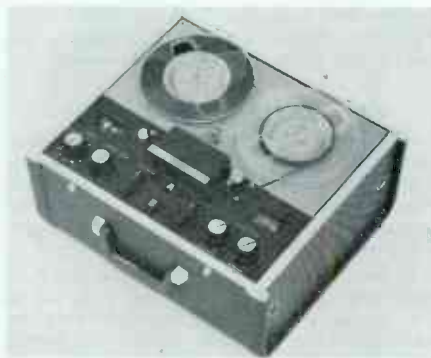
The low triggering voltage and current are largely due to the proprietary molybdenum sputtering technique used in the manufacture of the tube, and to the geometry of the electrodes. The technique is a method by which molybdenum is sprayed on the cathode and on a large area of the glass envelope to improve cathode stability and help maintain the purity of the neon/argon gas within the tube for reduced spread in characteristics. The electrode geometry consists of a ring-shaped cathode with ten evenly spaced holes into which the trigger electrodes are placed. Clearance between triggers and the cathode sectors is about 0.3 mm. Because of this small gap, a correspondingly low voltage between trigger and cathode can initiate the discharge, the manufacturer states, and no heating power or warm up time is required.



KAHN DUAL DIVERSITY SIDE BAND RECEIVER

Kahn Research Laboratories, Inc., 81 S. Bergen Place, Freeport, N. Y., has introduced the model DIV/RSSB 61-1A dual diversity sideband receiver, designed for point-to-point multi-channel radio-telephone, radio telegraph, or facsimile reception. The unit provides two independent, 6 kc receiving channels, and features an all-electronic, automatic frequency control circuit to reduce tuning errors and transmitter drifts of up to ± 2 kc to less than 1 or 2 cycles. Also included is a magnetic storage device which is said to insure proper tuning even during severe carrier fade.

According to the manufacturer, the unit, which is designed for rapid frequency changes, has incorporated a lighting arrangement whereby only the RF tuner to be tuned will have its associated front panel meters strongly illuminated. This overall arrangement is designed to eliminate operating errors, as well as making it possible for one receiver to carry traffic while the other is being tuned to a new frequency.



4-TRACK STEREO AND MONAURAL TAPE RECORDER/PLAYER

The new 1200 series, 4-track stereo and monaural tape recorder/player has been introduced by Ampex Video Products Co., 934 Charter St., Redwood City, Calif. The series features three newly designed heads (record, playback, and selective erase) designed to accommodate the narrower track widths of 4-track stereo, and monaural recording and playback.

A new tape tracking and guidance system, formerly used only in professional equipment, has also been incorporated in the series. In addition, the manufacturer states, over 170 other improvements have been made in this series to provide professional recording and reproduction quality for home and semi-professional use.

The 1200 series will be available in the portable model 1260; an unmounted deck, model 1250; a portable with built-in pairs of matched amplifier-speakers, model 1270; and as standard equipment in the new Crescendo II and Signature II consoles.



COAXIAL LINE DIRECTIONAL COUPLERS

Dielectric Products Engineering Co., Inc., Raymond, Maine, has released Bulletin 61-r, giving details on a line of coaxial line directional couplers, in both quick-clamp and EIA (RETMA) bolted-flange types, in line sizes $\frac{1}{8}$ -inch, 1%, 3%, 6% and 9 3/16 inches.

Particular features are high directivity and adjustable r-f output. Because the source impedance is matched to the characteristic impedance of connecting cable, the coupling coefficient is unaffected by cable length, the manufacturer states. Specifications, performance data and outline drawings are included for line impedances of 50, 51.5, and 75 ohm lines. Both 30 db and 40 db directivity models are available.

The couplers provide for coupling ex-

ternal measuring and monitoring equipment in tuning, operating, and maintenance measurements of r-f transmitters, directing and controlling devices, transmission lines, and antenna feed systems. Depending only on the angular orientation of the coupler, either the incident or the reflected wave is sampled. Reflectometers for VSWR and net power output measurements require two couplers, one for the incident, the other for the reflected wave.



PHASE AND GAIN EQUALIZER

American Microwave & Television Corp., 1369 Industrial Rd., San Carlos, Calif., has introduced the model VCE-1, phase and gain equalizer, designed for use in video circuits to correct for differential phase and gain errors in color TV systems or sync compression and white stretching in monochrome circuits.

The unit is passive, providing 0-3 DB differential gain correction, and 0-15 deg. differential phase correction.

Continental's AIR OR WATER COOLED 50 KW DUMMY LOADS



WATER COOLED



AIR COOLED

These dummy loads will dissipate the energy of a 50 KW transmitter at 100% modulation.

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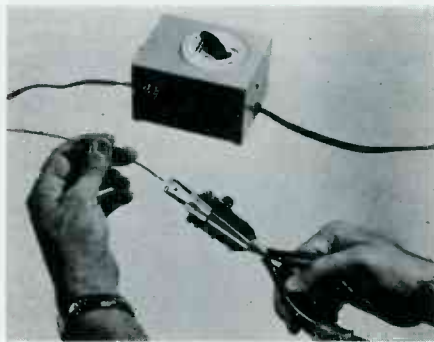
LOOKING FOR TUBES?

Turn to section 5700

eam — ELECTRONIC ENGINEERS MASTER



Product News



THERMAL WIRE STRIPPING PLIER

Hunter Tools, R. N. Hunter Sales Co., 9851 Alburto Ave., Santa Fe Springs, Calif., is offering a lightweight plier-like design, thermal wire stripper.

The unit is mounted on a standard Hunter plier frame and is long and slim to make it possible to reach deep into chassis and other electronic assemblies. A compact control for any degree of heat at the tips is said to make it possible to strip any type of insulation from low-temp vinyl to teflon.

The thermal stripping plier is said to sever and remove insulation in one quick operation. The unit will strip lengths from 1/8-inch up and can strip mid-wire sections. It can be used on multi-stranded or solid wires from 40 to 12 AWG, co-axial cables, shielded

cables, wire cord sets and assemblies, multi-conductor wires and flat conduction between two layers of insulating material.

NEW BROADCAST MICROPHONE

A new microphone, with built-in amplifier and earphone jack, for use by man-in-the-street radio-TV interviewers and for other remote broadcast pickups, has been introduced by Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N. Y.

In use, the unit attaches by cable to a telephone line for feeding the program to the studio. A miniature earphone plug enables the announcer both to hear telephoned cues from the studio and to monitor the microphone's output.

NEW UHF TELEVISION TRANSMITTERS

A new line of UHF television transmitting equipment, featuring simplicity, has been developed by ITA Electronics Corp., 130 E. Baltimore Ave., Lansdowne, Pa.

Aural and visual signals are generated in the common exciter. The visual output of the exciter goes through a vestigial sideband filtering network where the lower sideband is attenuated to conform to FCC

rules. Single Klystron tubes are used in the 15 and 30-KW transmitters, while two 30-KW amplifiers are combined to produce a 60-KW transmitter.

Silicon rectifiers are used in all power supplies, and full overload protection is designed to assure continuity of operation.

Classified

Advertising rates in the Classified Section are ten cents per word. Minimum charge is \$2.00. Blind box number is 50 cents extra. Check or money order must be enclosed with ad.

The classified columns are not open to the advertising of any broadcast equipment or supplies regularly produced by manufacturers unless the equipment is used and no longer owned by the manufacturer. Display advertising must be purchased in such cases.

EQUIPMENT FOR SALE

Transmission line, styroflex, heliax, rigid with hardware and fittings. New at surplus prices. Write for stock list. Sierra Western Electric Cable Co., 1401 Middle Harbor Road, Oakland 20, California. 6-61 tf

Commercial Crystals and new or replacement crystals for RCA, Gates, W. E., Bliley and J-K holders; regrounding, repair, etc. BC-604 crystals. Also A. M. monitor service. Nationwide unsolicited testimonials praise our products and fast service. Eidson Electronic Company, Box 31, Temple, Texas. 9-61 tf

HELP WANTED

Television Field Broadcast Engineer—1st phone, VHF and TV transmitter operation, installation and maintenance experience. Considerable travel involved, some foreign. Send resume to: Mr. D. K. Thorne, RCA Service Company, Cherry Hill, Camden 8, New Jersey. An Equal Opportunity Employer. 1-62 it

Needed, first class engineer—Good salary. Write WNKY, Box 248, Neon, Kentucky, or call 7714 or apply in person. 12-61 2t

Television Director of Engineers—Permanent employment, must be experienced in installation, operation and maintenance. Ability to modify and construct transmitter, convert present equipment from Channel 13 operation to Channel 12. Send resume—Mr. Joseph A. Paretti, President, New Orleans Television Corporation, Station WVUE, New Orleans, La. Phone JA 5-9011. 1-62 it

OLD LINE DIVERSIFIED PHOTOGRAPHIC AND AUDIO-VISUAL EQUIPMENT MANUFACTURER LOCATED IN THE NORTH-EAST NEEDS: An Electronics Engineer—Having experience with the design of optical and magnetic sound-recording equipment, one with a thorough understanding of photographic and motion picture sound techniques. A Mechanical Engineer—With experience in the design of optical and magnetic sound-recording equipment, together with a broad knowledge of photographic equipment design, including projectors. A Sound-Recording Engineer—Experienced in recording motion picture sound tracks, transferring, mixing and editing. Must have experience with current high quality recording equipment. This is an opportunity to work together with a team engaged in finalizing the design of a new series of patented audio-visual and sound products and toward a program of systematic planned improvements of these designs. Broadcast Engineering, Dept. BE 6, Kansas City 5, Mo. 1-62 1t

BUY, SELL OR TRADE

Will buy or trade used tape and disc recording equipment — Ampex, Concertone, Magnecord, Presto, etc. Audio equipment for sale. Boynton Studio, 10 BE Pennsylvania, Tuckahoe, N. Y. 10-61 6t

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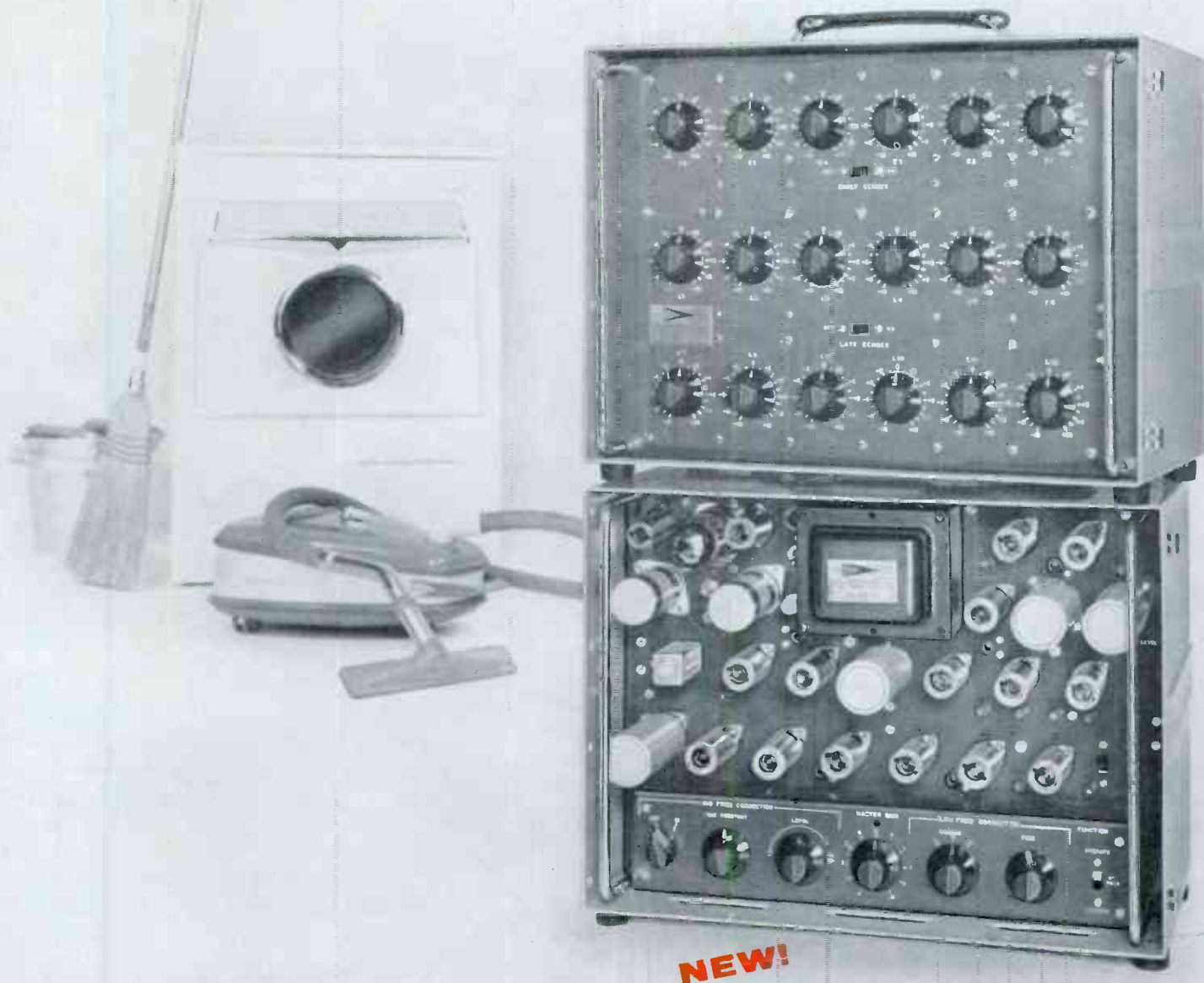
• SYNCHRONOUS MAGNETIC FILM RECORDER/REPRODUCER

• MAGNETIC TAPE RECORDERS
• NEW—THE portable MINTAPE synchronous 13 lb., battery operated magnetic tape recorder for field recording.

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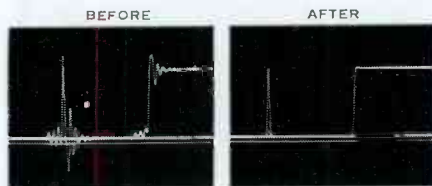


NEW!

...clean-up video distortions easily



Photos, taken a few seconds apart, show how the Model 20/20 cleans up smears, overshoots, ringing and other waveform defects.



Waveform correction is illustrated by before-and-after photos of an expanded portion of Sine²-test signal. The Model 20/20 can be used with any desired test signal for pre-broadcast, or on-the-air correction.

At the recent NAB show, Telechrome demonstrated a remarkable new device, the Model 20/20 Time Domain Equalizer. If you saw it in operation at the show, you were, no doubt, amazed at the ease with which it corrected streaking, smearing, ringing and overshoots. If you have antenna mismatch problems due to icing, etc., inadequate transmitter phase correction, video tape degradation, distortions on remotes or STL links, or, in short, almost any video distortion problem, let us demonstrate the 20/20 to you and your staff.

*Prove the value of the 20/20 at your own facilities
for on-the-air or pre-broadcast signal corrections.*

The 20/20 requires no special signals or set up, so a few minutes of your time is all that is necessary to produce the picture that is worth the proverbial thousand words. For your demonstration contact H. Charles Riker, Vice President Marketing. No obligation of course.

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RCA-5762A POWER TRIODE FOR TV & FM



AN IMPROVED VERSION OF A PROVEN FAVORITE

For years telecasters have known and relied on the RCA-5762. Now the 5762A combines the rugged dependability of the original with important improvements.

The 5762A is unilaterally interchangeable with the 5762/7C24. Its entirely new grid design and grid characteristics make it ideal for both TV and FM. Its maximum plate dissipation is 4 Kw and it can be used at the highest VHF channel. The synchronizing-level power output is 6.35 Kw with less than 1 Kw of driving signal.

The new type retains the highly efficient radiator of its predecessor; the thoriated tungsten filament for economical power consumption; the complete shielding between filament leads and plate; the low grid-to-plate capacitance; and the high perveance. It is a worthy successor to one of the most respected tubes in broadcasting.

Also from RCA...

A NEW GENERATION OF BROADCAST VETERANS

Every familiar RCA broadcast tube has been steadily improved over the years. Each of the types below, manufactured for years, are in service in hundreds of transmitters. Today's *improved* versions represent the best transmitting tube investment the broadcaster has ever been able to make.

No.	Type	Typical Broadcast Application	Service	Plate Dissipation Watts	Power Output Watts
813	Beam Power Pentode	TV	AF Power Amplifier and Modulator	100 (CCS)	380 (two tubes)
833A	Power Triode	TV Radio	AF Power Amplifier and Modulator	300 (CCS)	1650 (two tubes)
6166A/7007	Beam Power Tube	TV	RF Power Amplifier	12,000 (CCS)	14,000
575A	Half-Wave Mercury-Vapor Rectifier	TV Radio	Half-Wave Rectifier		
673	Half-Wave Mercury-Vapor Rectifier	TV Radio	Half-Wave Rectifier		
866A	Half-Wave Mercury-Vapor Rectifier	TV Radio	Half-Wave Rectifier		
872A	Half-Wave Mercury-Vapor Rectifier	TV Radio	Half-Wave Rectifier		
8008	Half-Wave Mercury-Vapor Rectifier	TV Radio	Half-Wave Rectifier		

Be sure you have the latest ratings and technical data on these important tube types. Check with your Authorized RCA Broadcast Tube Distributor this week—or write directly to Commercial Engineering, Section A-115-0, RCA Electron Tube Division, Harrison, N. J.



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